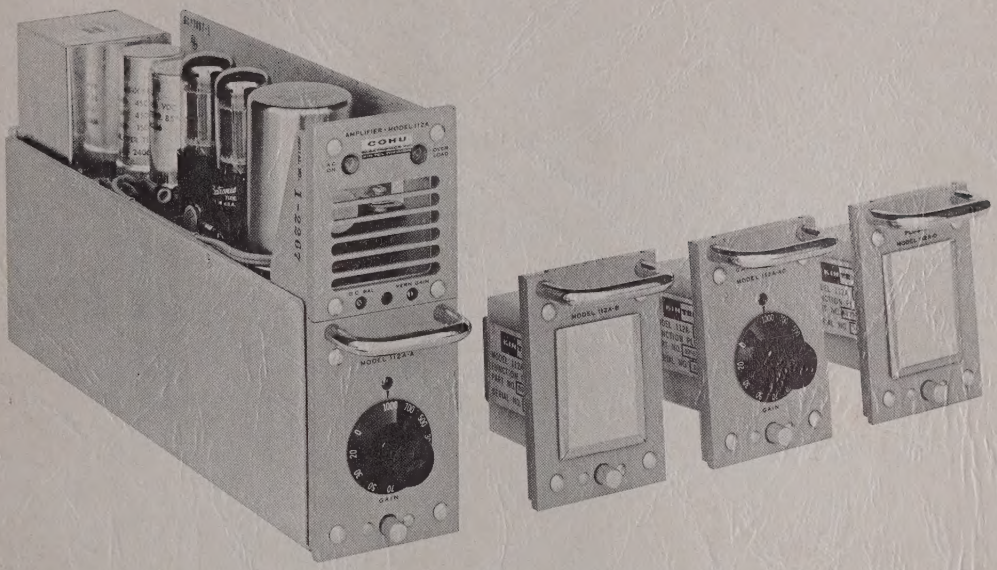

OPERATING AND MAINTENANCE
INSTRUCTIONS FOR

WIDEBAND DC AMPLIFIERS

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MODEL 112A SERIES

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COHU
ELECTRONICS, INC
KINTEL DIVISION

MANUAL PRICE $20.00
Technical Manual
Code No. 2X-62

OPERATING AND MAINTENANCE INSTRUCTIONS FOR MODEL 112A WIDEBAND DC AMPLIFIER

SERIAL NUMBER EFFECTIVITY: 1-0001 through 1-3000

ACCESSORY	TITLE
112A-A	Function Plug-In, Variable Gain
112A-A+AO	Function Plug-In
112A-AO	Function Plug-In, Operational/Variable Gain
112A-B	Function Plug-In, Unity Gain
112A-O	(Empty Function Plug-In for Construction of Operational Network)

The supplementary sections of this volume constitutes a separate and semi-autonomous manual. It provides coverage for specific function plug-ins or modular attenuators, thus supplementing more generalized data for this portion of the amplifier assembly which is incorporated in the basic amplifier manual. For this reason, the manual for the Model 112A Wideband DC Amplifier will not be considered incomplete with the supplements listed following the Table of Contents.

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COHU ELECTRONICS, INC.
Box 623, San Diego, California 92112

15 JUNE 1966

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INSTRUCTION MANUAL CHANGES

Change No. 1
1 December 1963

Code No. 2X-62

MODEL 112A WIDEBAND DC AMPLIFIER

SERIAL EFFECTIVITY: 1-0001 through 1-3000 and above

CHANGES IN TEXT:

Page 3-1: Figure 3-1. Label the amplifiers in the block diagram $+K_1$, $-K_3$, and $+K_2$ reading from left to right and from top to bottom.

Page 3-3: Figure 3-2. In the text, (reference Change 1, Paragraphs 3-20, 3-23, and 3-34) $+K_W$ refers to amplifiers V301A and V302; $-K_O$ refers to amplifiers V201 and V202; and $+K_C$ refers to amplifiers V301B, V304, and V305.

Page 3-4: Paragraph 3-20. Change heading to HIGH FREQUENCY AMPLIFIER, $+K_W$.

Paragraph 3-23. Change heading to CHOPPER AMPLIFIER, $+K_C$.

Page 3-7: Paragraph 3-34. Change heading to OUTPUT DRIVER STAGE, $-K_O$.

Page 4-8: Paragraph 4-34, lines 11-13. Delete the sentence, "It is recommended..."

Paragraph 4-36, line 9. The bias cell potential should be 1.344 volts.

Page 4-9: Figure 4-10. Reverse the orientation of the battery symbols. The polarity markings are correct and a negative voltage is applied to pin 1.

Page 4-10: Paragraph 4-46, lines 13-16. Underscore this sentence, "WHEN REINSTALLING THE CHOPPER, BE SURE TO MAINTAIN THE ORDER OF ASSEMBLY FOR WASHERS AS SHOWN IN THE EXPLODED VIEW IN FIGURE 4-11." This instruction is extremely important to follow when servicing choppers.

Page A4-4: Paragraph 4-23, line 6. The missing figure number is Figure 4-32.

Page A4-9: Figure A4-7. Add drawing number "(Dwg. No. 8079010)."

Page AO4-3: Figure AO4-3. Add drawing number "(Dwg. No. 8091001G)."

Page B3-2: Figure B3-1. Add drawing number "(Dwg. No. 8079002B)."

Page O2-7: Figure O2-5. Add drawing number "(Dwg. No. 8091001G."

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INSTRUCTION MANUAL CHANGES

Change No. 1 (Contd)
1 December 1963

Code No. 2X-62

PARTS CHANGES:

Table 4-5. List of Replaceable Parts

CIRCUIT REF.	DESCRIPTION	SERIAL NUMBER EFFECTIVITY FROM	KIN TEL PART NO.
C202	CAPACITOR, ELECTROLYTIC, P.C. 40/20 MF	1-2501	0510127-007
C203	CAPACITOR, CERAMIC DISC, .02 MF, 600V	1-1501	0401058
C207	CAPACITOR, CERAMIC DISC, 50 PF, 1000V (SERIAL NUMBER EFFECTIVITY) 1-0127*, 1-0135*, 1-0155 through 1-0158, 1-0166*, 1-0177*, 1-0179*, 1-0180*, 1-0182*, 1-0189*, 1-0190*, 1-0251*, 1-0267*, 1-0272*, 1-0477*, 1-0555*, 1-0698*, 1-0701*, 1-0703 through 1-0706, 1-0720*, 1-0716*, 1-0722 through 1-0727, 1-0800 through 1-0804, 1-0806*, 1-0809 through 1-0841, 1-0843 through 1-0851, 1-0854*, 1-0863*, 1-0866*, 1-0907 through 1-0931*, 1-0945 through 1-0957, 1-0964 through 1-0967, 1-0969*, 1-0971*, 1-0973 through 1-0984, 1-0986*, 1-0988 through 1-0994, 1-1033 through 1-1040	AS NOTED AND FROM 1-1056	0401016
C208	CAPACITOR, CERAMIC DISC, 300 MF, 1000V	1-2701	0401032
C305	CAPACITOR, CERAMIC DISC, .002 MF, 500V	1-0001	0401048
C304	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018
C307	CAPACITOR, MYLAR, .05 MF, 600V	1-2801	0610099-020
C308	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018
C309	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018

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INSTRUCTION MANUAL CHANGES

Change No. 1 (Contd)
1 December 1963

Code No. 2X-62

PARTS CHANGES:

Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT REF.	DESCRIPTION	SERIAL NUMBER EFFECTIVITY FROM	KIN TEL PART NO.
C310	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018
C311	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018
C312	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018
C313	CAPACITOR, MYLAR, FILM, .1 MF, 400V	1-2801	0610067-104
C317	CAPACITOR, MYLAR, .47 MF, 200V	1-2801	0610099-022
C318	CAPACITOR, MYLAR, .01 MF, 600V	1-2801	0610099-018
C414	CAPACITOR, MOULDED, SILVER-MICA, CM-15, 110 PF	1-0076	1010000-027
CR301	DIODE, SILITRON, CER71A	1-1301 through 1-2800	3510053-001
CR301	DIODE, 1N3563/SC-10A	1-2801	3510053-006
CR302	DIODE, SOLITRON, CER71A	1-1301 through 1-2800	3510053-001
CR302	DIODE, 1N3563/SC-10A	1-2801	3510053-006
CR303	DIODE, SOLITRON, CER71A	1-1301 through 1-2800	3510053-001
CR303	DIODE, 1N3563/SC-10A	1-2801	3510053-006
CR304	DIODE, SOLITRON, CER71A	1-1301 through 1-2800	3510053-001
CR304	DIODE, 1N3563/SC-10A	1-2801	3510053-006
CR305	DIODE, SOLITRON, CER69	1-1301	3510053-003
CR306	DIODE, SOLITRON, CER69	1-1301	3510053-003
CR311	DIODE, SOLITRON, CER71A	1-1301	3510053-001
CR312	DIODE, SOLITRON, CER71A	1-1301	3510053-001
D101	CHOPPER, CH601 (INTERCHANGEABLE WITH 6310010-001 WHICH IS NOW OBSOLETE)	1-0001	6310017-001

INSTRUCTION MANUAL CHANGES

Change No. 1 (Contd)
1 December 1963

Code No. 2X-62

PARTS CHANGES:

Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT REF.	DESCRIPTION	SERIAL NUMBER EFFECTIVITY FROM	KIN TEL PART NO.
DS101	INDICATOR LAMP ASSEMBLY, WHITE	1-3001	1710152-003
DS102	INDICATOR LAMP ASSEMBLY, WHITE	1-3001	1710152-003
L201	CHOKE, 2 μH (FOR 112A AMPLIFIER)	------	6710011-003
R201	RESISTOR, 1/2W, 5%, 1.2 MEG	1-1301	0310030-125
R341	RESISTOR, 1W, 5%, 100K	1-1301	0310031-104
T101	TRANSFORMER, POWER, 115/220V, MODEL 112A/458C	1-2701 through 1-2900	6510123-001
T101	TRANSFORMER, POWER, MODEL 112A/458C	1-2901	8077301-001
V302	TUBE, 6AU6A, GE ONLY	1-1301 through 1-1307	7010041-001

Code No. 2X-62S-A

Table A4-1. List of Replaceable Parts, Model 112A-A Function Plug-In

CIRCUIT REF.	DESCRIPTION	SERIAL NUMBER EFFECTIVITY FROM	KIN TEL PART NO.
CR401	DIODE, 1N628	1-1421	3510004
CR402	DIODE, 1N628	1-1421	3510004

COHU ELECTRONICS, INC
KIN TEL DIVISION

INSTRUCTION MANUAL CHANGES

Change No. 2
1 FEBRUARY 1965

Code No. 2X-62

MODEL 112A WIDEBAND DC AMPLIFIER

SERIAL EFFECTIVITY: 1-2501 and above

CORRECTION: Change 1, page C2 — KIN TEL Part No. for C202 should be 0510121-007.

Change No. 3
1 JUNE 1966

SERIAL EFFECTIVITY: 1-0001 and above

PARTS CHANGE:

Table 4-5. List of Replacement Parts

CIRCUIT REF.	DESCRIPTION	SERIAL NO. EFFECTIVITY FROM	KIN TEL PART NO.
C305	CAPACITOR, CERAMIC DISC, .002 μF, 500V	1-0001 and above	0401048

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LIST OF SUPPLEMENTAL FUNCTION PLUG-IN MANUALS

Title	Code No.
Model 112A-A Amplifier Function Plug-In (Variable Gain)	2X-62S-A
Model 112A-A+AO Function Plug-In	2X-62S-A+AO
Operating and Maintenance Instructions for Model 112A-AO Function Plug-In (Operational Variable Gain)	2PX-62S-AO
Model 112A-B Function Plug-In	2X-62S-B
Model 112A-O Amplifier Function Plug-In (For Operational Network Construction)	2PX-62S-O

NOTE: These supplemental sections follow Section IV of the amplifier manual in the order given.

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Section I
GENERAL DESCRIPTION

1-1 INTRODUCTION

1-2. KIN TEL Wideband DC Amplifiers are rugged precision instruments specifically designed to accept very small DC signals having transients up to several kilocycles and, through very linear, highly stable amplification, to provide low impedance output signals for driving conventional instrumentation equipment.

1-3. Design refinements over a period of years have produced a progression of highly versatile units which are serving as basic components of all types of data transmission systems.

1-4 IDENTIFICATION

1-5. The KIN TEL Model 112A Wideband DC Amplifier (Figure 1-1) is a single-ended unit designed to meet the exacting requirements of high-accuracy DC instrumentation systems in adverse environments.

1-6. The Model 112A provides advanced cooling facilities, allowing operation in higher ambient temperatures; improved mechanical construction, permitting operation while being subjected to shocks greater than 5 g's; greater ease of maintenance, through increased accessibility; extended versatility due to modular attenuator design.

1-7. Front panel construction of the amplifier incorporates a compartment for the insertion of "Function Plug-In" (attenuator) assemblies. Thus one Model 112A may serve as many instruments without removing the amplifier from its cabinet or rack for modification. The Model 112A-A Function Plug-In (Figure 1-2) provides gain steps of 0, 20, 30, 50, 70, 100, 200, 300, 500, 700, and 1000 with continuous 1 to 2 times variation of each step by potentiometer. The Model 112A-B Function Plug-In provides a fixed gain of +1. Other plug-in units available will instantly convert the Model 112A into an integrator, a summing amplifier, or an amplifier with special fixed or variable gain of any required precision, depending upon the needs of the installation.

Figure 1-1. Model 112A Wideband DC Amplifier

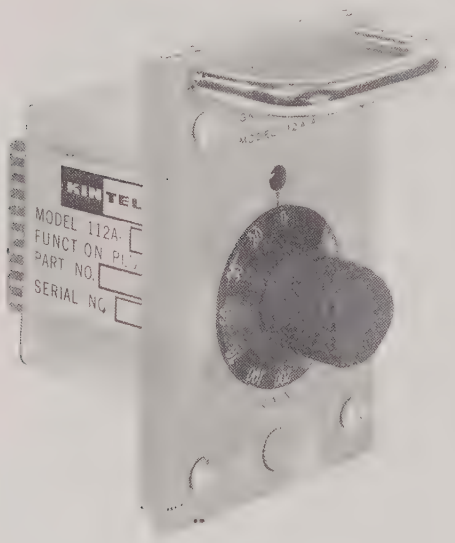


Figure 1-2. Model 112A-A Function Plug-In Assembly

1-8. A continuously variable front panel control allows gain to be increased to as much as two times the gain determined by the Function Plug-In.

1-9. An additional control on the Model 112A-A Function Plug-In (factory-adjusted at optimum setting) permits precision gain setting to beyond a measurable accuracy. This Micro-Gain adjustment is of such a critical nature that applications requiring its use are comparatively rare, but it furnishes a "bonus" precision in gain setting when needed.

1-10 APPLICATIONS

1-11. The Function Plug-In feature of the Model 112A makes it ideally suitable to installations which may be used for more than a single application. It serves as a standard amplifier for transducers in the measurement of flow, displacement, noise, pressure, strain, temperature, torque, and vibration, and it provides output to such devices as digital voltmeters, strip recorders, wideband oscillographs, voltage-controlled oscillators, recording galvanometers, tape recorders, analog-to-digital converters, computers, process control elements, and multiplexers.

1-12 PACKAGING

1-13. The Model 112A is designed for use in either of two housings: The Model 195 Cabinet (Figure 1-3), which is of hand-carry design, accepts a single amplifier, and the Model 190 module (Figure 1-4) accommodates six amplifiers, and is sized and drilled for mounting in a standard 19-inch rack.

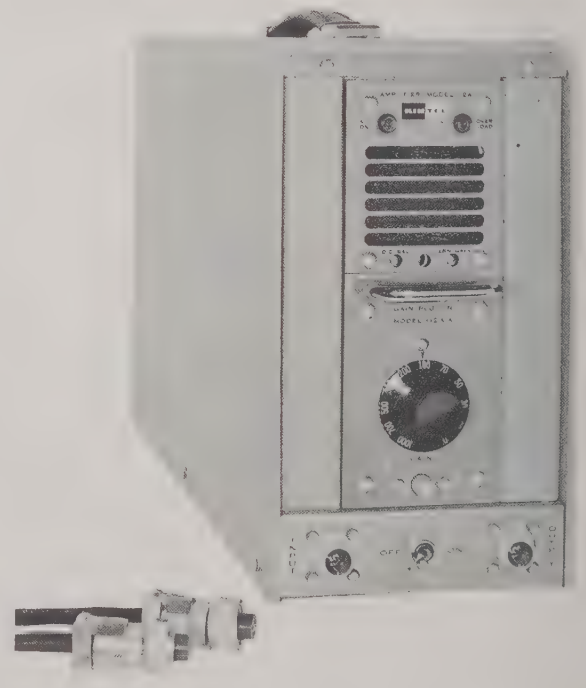


Figure 1-3. Model 112A Installed in Model 195 Cabinet

NOTE

These housings also accept all other KIN TEL amplifiers.

1-14. Cannon connectors in the rear of either type housing (Figures 1-5 and 1-6) automatically contact the mating connector on the rear of the amplifier being inserted into the housing (Figure 1-1). Through these connections, the AC-wired housing supplies operating power to the amplifier and completes amplifier circuit connections to the standard input and output cable connectors located on the front of the housing.

1-15. An amplifier may be quickly removed from a Model 190 module and placed in a Model 195 Cabinet for ease in transporting or for use as a single unit away from the permanent or semi-permanent rack module installation.

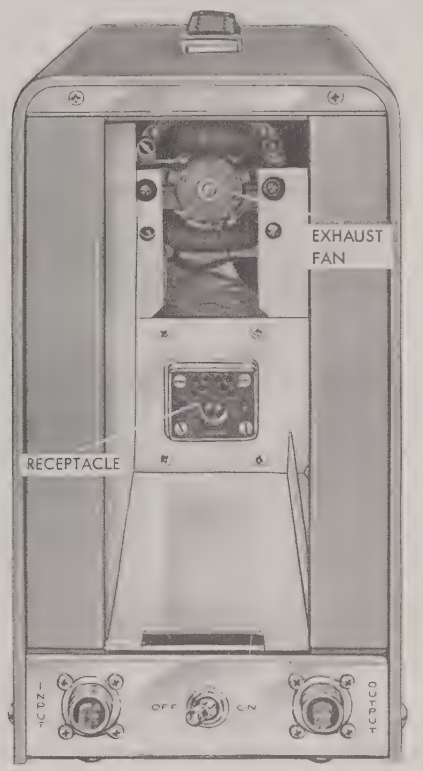


Figure 1-5. Model 195 Cabinet Interior, Showing Amplifier Connector and Blower

Figure 1-4. Model 190 Rack Module with Model 112A Wideband DC Amplifiers and Model FP190 Filler Panels Installed

1-16 PHYSICAL DETAILS

1-17. The Model 112A amplifier (Figure 1-1) has a long, narrow form and is installed in its special housings (Figures 1-3 and 1-4) as a drawer with plug-in connections at the rear.

1-18. The front panel is constructed in two sections. The top portion is a fixed panel which may be considered a permanent member of the basic amplifier assembly. The bottom portion is a part of the particular Function Plug-In being used. The top section of the panel incorporates pilot and overload indicator lights, recessed (screwdriver-adjusted) controls for adjusting DC balance and vernier gain (refer to paragraph 1-8), and ventilating slots for air intake.

1-19. The bottom section of the front panel incorporates the handle (for ease in drawer insertion and removal, and carrying the amplifier when out of its housing). A latch is located at the bottom for locking the amplifier in place. Additional control features will vary with the particular Function Plug-In used. Some plug-ins, such as the Model 112A-A, incorporate the Micro-Gain control mentioned in paragraph 1-9.

1-20. Mechanical design and construction provide maximum protection from stress and shock. Heavier components are mounted at the rear of the chassis to facilitate easy insertion and removal of the units and to increase mechanical stability when units are partly withdrawn from the housing. The right side of the chassis is a shield which extends to the full height of the amplifier to serve as an effective inter-unit shield in multi-amplifier installations.

1-21. MODEL 195 CABINET. The Model 195 Cabinet (Figure 1-3) is a sturdy metal case designed to accept a single Model 112A amplifier (or other KIN TEL amplifiers noted in paragraph 1-13). It receives the amplifier as a drawer, and incorporates a connector (Figure 1-5) which mates with the connector on the rear of the amplifier chassis (Figure 1-1).

1-22. A small panel located just below the amplifier opening is used for mounting the input and output connectors and the ON-OFF switch which controls application of line voltage to the amplifier and to the exhaust fan mounted in the back of the housing (Figures 1-5 and 1-7). The AC line cord is brought into the rear of the cabinet

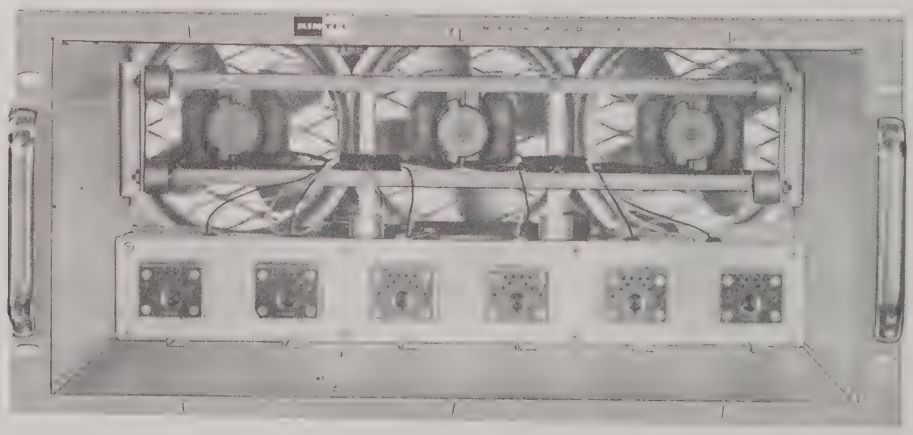


Figure 1-6. Model 190 Module Interior, Showing Amplifier Connectors and Blowers

Figure 1-7. Model 195 Cabinet, Rear View

near the bottom, adjacent to the conveniently located extractor-type receptacle which houses the AC line fuse (Figure 1-7).

1-23. MODEL 190 RACK MODULE. The Model 190 module is a ruggedly constructed metal housing designed to accommodate six amplifiers. It is sized and drilled for mounting in a standard 19-inch rack, to which it is secured by standard mounting screws. It receives the amplifiers as drawers, and insertion is guided by the mating of an alignment slot in the bottom of the amplifier with a metal tab which is located on the inner floor of the module, thus directing the union of the electrical connectors on amplifier and module. The module connectors are mounted on a panel in the rear of the module (Figure 1-6) and are accessible for wiring modifications or service checks by the removal of a cover panel (Figure 1-8).

1-24. Exhaust fans in the upper rear portion of the module furnish cooling facilities which permit up to six amplifiers to perform within ambient temperature specifications (Figures 1-6 and 1-8).

1-25. The AC line cord is brought into the rear of the module and directly connected to the exhaust fans and the amplifier connectors. No switch is used in the Model 190 module. Grom-

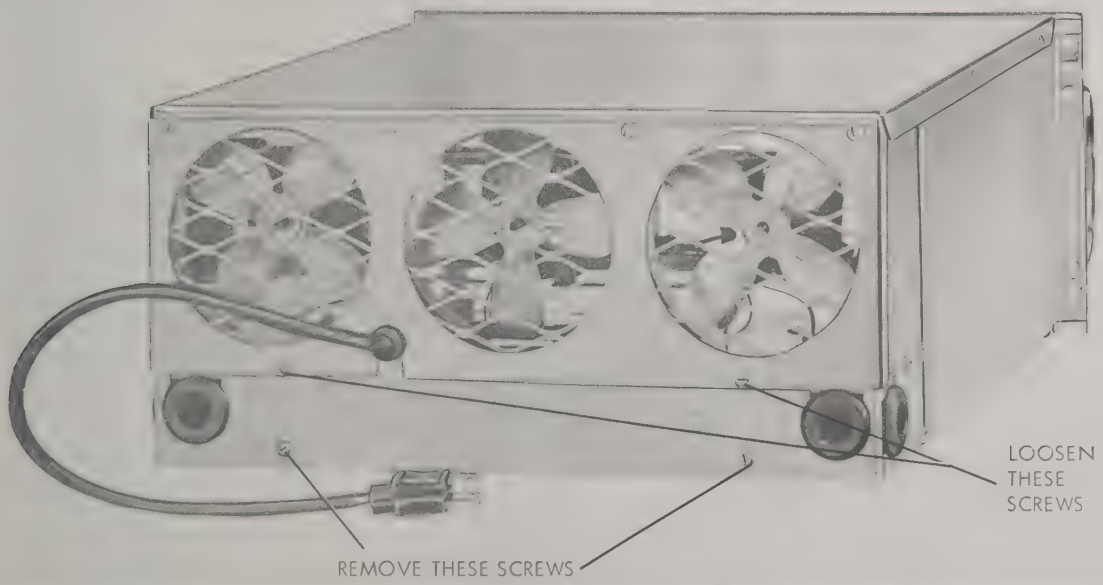


Figure 1-8. Model 190 Module, Rear View

meted openings at the four lower rear corners provide for passage of input and output cables which are terminated at the respective pins of the amplifier connectors at the time of installation. See Figure 1-8.

1-26. As evidenced in Figure 1-4, filler panels are available to cover spaces in the facade of the module when less than six amplifiers are installed. These are ordered by the designation: Model FP190 Filler Panel.

1-27. Detailed installation and maintenance instructions for the Model 190 module are given in the technical manual for the module (KIN TEL publication Code No. 2X-60).

1-28 DIMENSIONS

1-29. Dimensions of the Model 112A Wideband DC Amplifier and the Model 195 Cabinet and Model 190 module are shown in Figure 1-9.

1-30 SPECIFICATIONS

1-31. Specifications (other than dimensions) for the Model 112A and both housings are listed in Table 1-1.

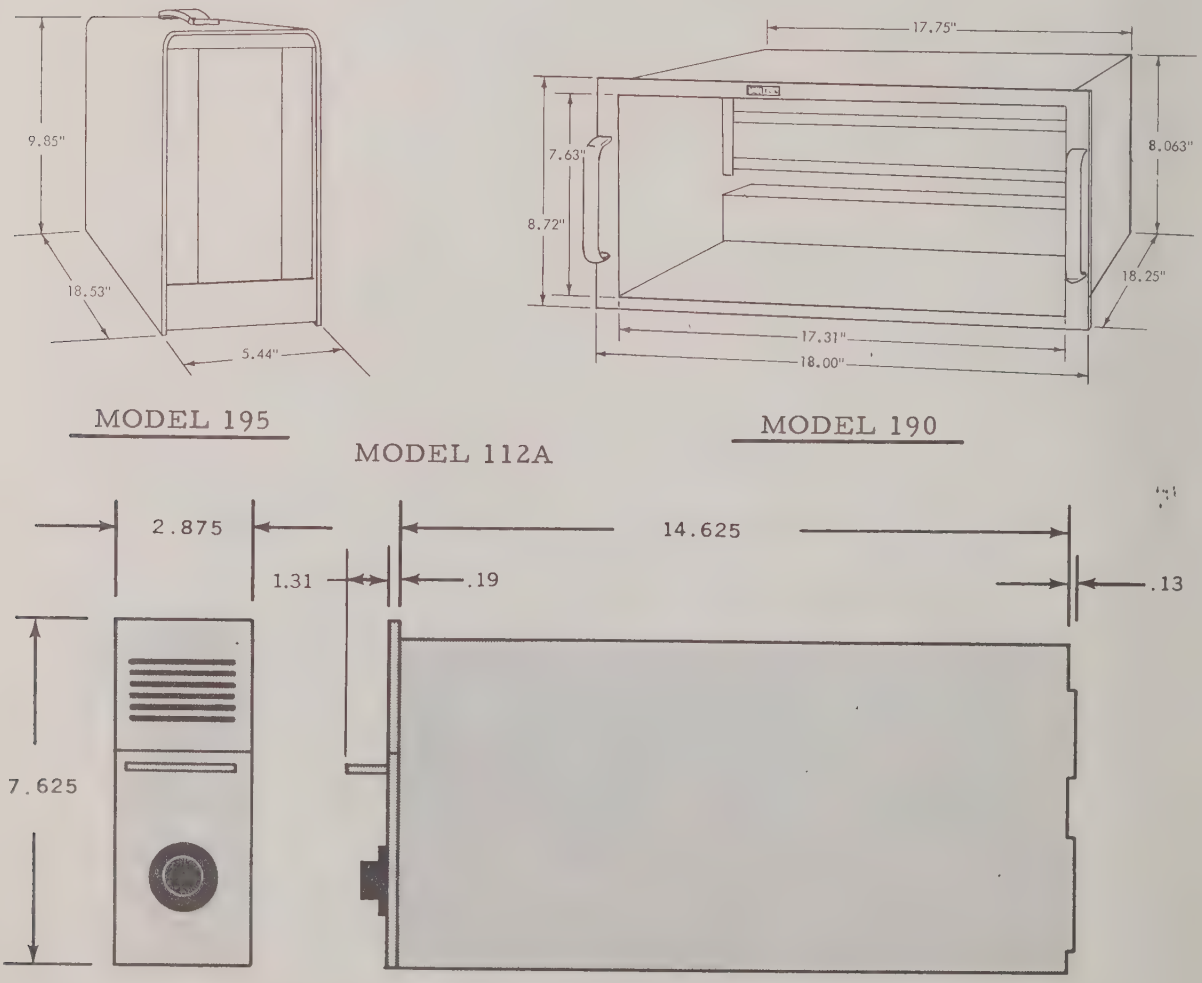
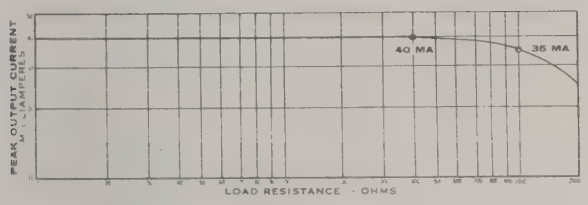


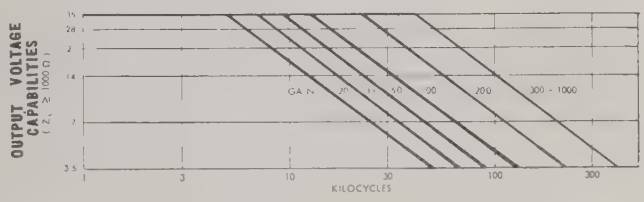
Figure 1-9. Outlines and Dimensions, Models 112A, 190 and 195

Table 1-1. Specifications, Models 112A, 190, and 195

(The following preliminary specifications apply to the KIN TEL Model 112A Wideband DC Amplifier with the Model 112A-A Gain Plug-In Unit.)

GAIN WITH 112A-A PLUG-IN (Phase Inverting)	Steps of 0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000, with continuous 1 to 2 times variation of each step by potentiometer
GAIN ACCURACY	±0.5% DC to 2 kc (Micro-Gain adjustment on 112A-A Plug-In permits setting individual gain steps to better than ±0.01% accuracy)
GAIN STABILITY	0.1%
INPUT IMPEDANCE	100,000 ohms
OUTPUT IMPEDANCE	Less than 1 ohm in series with 25 microhenries
EQUIVALENT INPUT DRIFT (After Warmup)	Less than ±2 microvolts for 400 hours or more when used with regulated line voltage, ±10% change in AC line input causes less than ±5 microvolt change
EQUIVALENT INPUT NOISE	0 to 3 cps, less than 5 microvolts peak to peak; 0 to 750 cps, less than 5 microvolts RMS; 0 to 50 kc, less than 12 microvolts RMS
CHOPPER INTERMODULATION	Less than 0.1%
MAXIMUM OUTPUT CABLE CAPACITY	0.5 microfarad (external)
LINEARITY	Better than 0.05% to 1 kc and 0.1% to 2 kc to full output, better than 0.01% at DC to full output
DC OUTPUT CAPABILITY	Up to ±35 volts where load resistance is 1000 ohms, up to ±45 volts where load resistance is 10,000 ohms or above; up to 40 milliamperes where load resistance is between 10 and 400 ohms (see Fig. 1 below for capabilities between 400 and 2000 ohms)
PEAK AC OUTPUT CAPABILITY	±35 volts from 0 to 40 kc on gain ranges of 300 or above, where load impedance is 1000 ohms or greater, (see Fig. 2 below for AC output capability at lower gain settings)





FREQUENCY RESPONSE	±0.5% to 2 kc, ±3% to 10 kc, less than 3 db down at 40 kc
RISE TIME	Less than 10 microseconds to within 1%, 20 microseconds to 0.1% of fina value
PHASE SHIFT	Less than 5° to 2 kc
OVERLOAD RECOVERY TIME	Less than 3 seconds
LEAKAGE RESISTANCE BETWEEN CHASSIS AND SIGNAL GROUND	The impedance between the amplifier chassis (connector pin 4) and the signa common leads (connector pins 1 and 11) exceeds 50 megohms at DC and 0.5 megohm at 60 cycles for floating operation (500v max. between pins 1 & 11)
POWER REQUIREMENTS	112A Amplifier: 117 volts (105 to 125 volts), 60 cps, 70VA; 195 Cabinet for single amplifier (1 fan): 117 volts, 60 cps, 15VA; 190 Rack Adapter Module for 6 amplifiers (3 fans): 117 volts, 60 cps, 45VA
WEIGHTS	Amplifier: 11 lb net, 23 lb shipping wt; 195 Cabinet (for any single 112A Amplifier — includes fan and connectors) — 13 lb net, 18 lb shipping wt 190 Rack Adapter Module (for any six 112A series amplifiers — includes connectors and 3 fans) — 34 lb net, 49 lb shipping wt
DIMENSIONS	Amplifier: 2-7/8" wide, 7-5/8" high, 14-5/8" deep; 195 Cabinet (for any single 112A Amplifier) 5-7/16" wide, 10" high, 18-1/4" deep; 190 Rack Adapter Module (for any six 112A Amplifiers) 19" wide, 8-3/4" high, 18-1/4" deep (width of module behind front panel is 17-5/8")

Section II
OPERATION

2-1 UNPACKING

2-2. KIN TEL Model 112A Amplifiers are individually wrapped and enclosed in padding, and shipped in single cartons, or in lots of two or three per carton.

2-3. MODEL 195 CABINETS. If a Model 195 Cabinet is to be included in an amplifier shipment, the amplifier is installed in the cabinet before packing, and the associated connectors (which mate with those on the cabinet front) are taped to the AC line cord.

2-4. MODEL 190 MODULES. If a Model 190 module is shipped with amplifiers, it is always packed separately. If less than six amplifiers are to be installed in a module, filler panels are shipped to occupy the blank spaces. These will be found wrapped and placed either within the module or directly behind it adjacent to the ventilation ducts.

2-5. CALIBRATION SHEETS. The calibration sheet for each amplifier is enclosed in a white envelope and taped to the external surface of the vertical metal shield on the right side of the amplifier. Care should be exercised to locate and remove this calibration sheet before discarding packing materials. If an amplifier is shipped in a Model 195 Cabinet, release the catch at the bottom center of the front panel (this will have been especially tightened for security during shipment and will take considerable torque to loosen for release), and withdraw the amplifier from the cabinet for inspection and to obtain the calibration sheet.

2-6. INSPECTION. Each item should be inspected as unwrapped, to ascertain that no damage has been incurred during shipment. If all items appear to be undamaged, operational tests should be made as soon as possible. If any damage is revealed, claim should be filed with the carrier, stating the extent of damage.

2-7 SETTING UP

2-8. Instruction and information are included here for setting up a Model 112A Amplifier, an amplifier in a Model 195 Cabinet, and a bank of amplifiers in a Model 190 Rack Module.

2-9. AMPLIFIER ONLY. The Model 112A amplifier may be operated in a cabinet devised by the user, if proper ventilation is provided. The unit may be operated with no housing at all if adequate precautions are taken to provide shielding while maintaining proper ventilation. Some difficulty may be encountered with drift if the circuit heats in the absence of a scientifically directed cooling air stream; in most cases it will be advisable (even when no housing is used) to direct the airstream from a small fan against the amplifier.

2-10. When used outside of housings, amplifier connections must be made with a special connector which mates with the plug on the rear of the amplifier chassis. To preclude the necessity of preparing special connector-and-cable assemblies, Model 111TC Test Cable (Figure 2-1) may be ordered under KIN TEL part number 8013000. To facilitate connecting and discon-

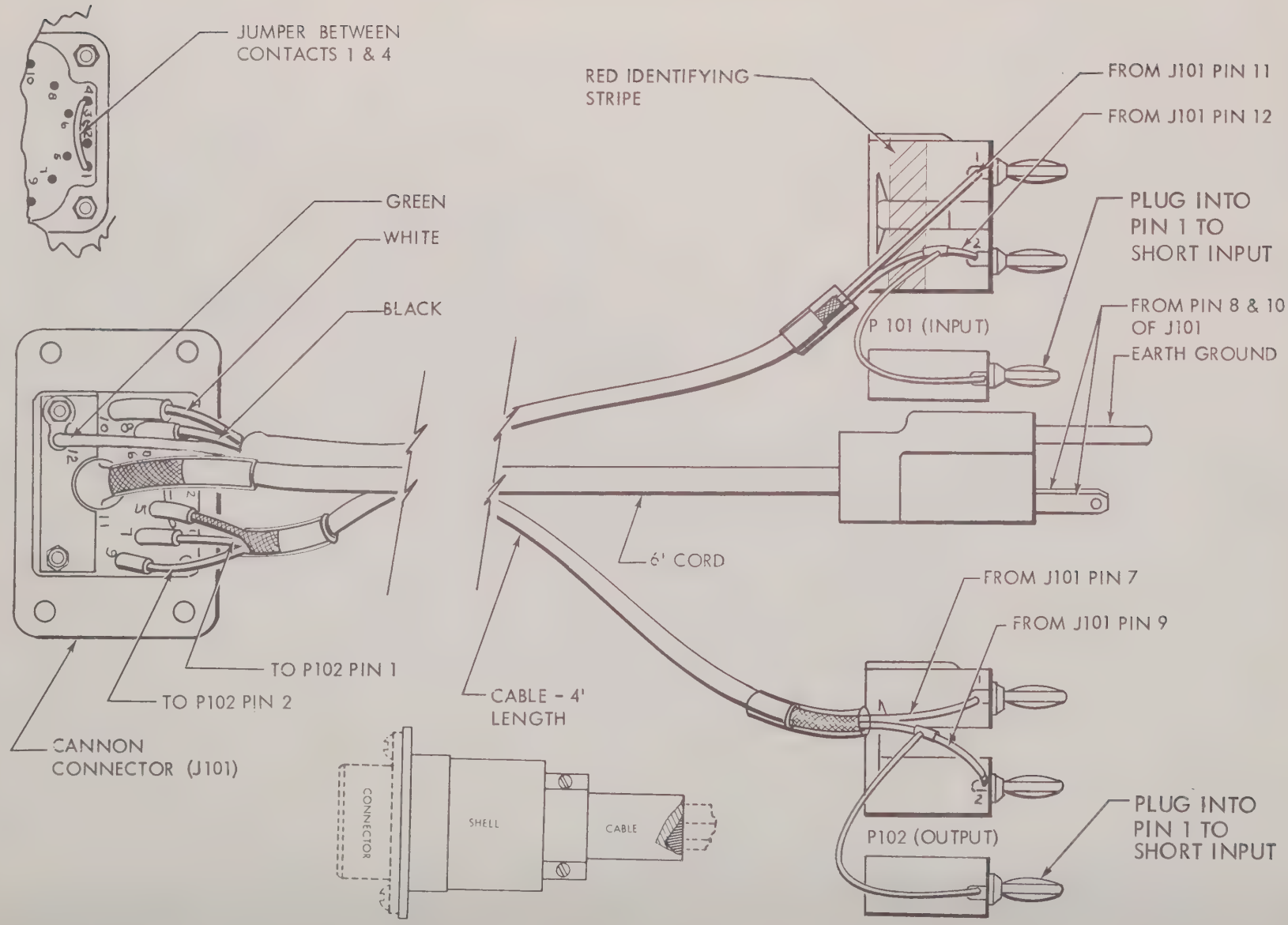


Figure 2-1. Model 111TC Test Cable (Refer to Paragraph 2-10)

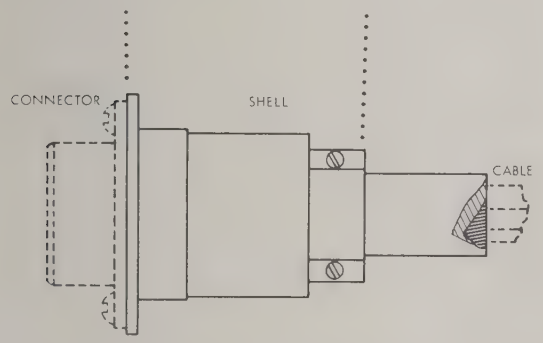


Figure 2-2. Connector Shell for Test Cable (Refer to Paragraph 2-10)

necting cable and amplifier and to provide connection shielding, the shell (Cannon DPB 34) shown in Figure 2-2 is included in the assembly, although it is not shown as included in Figure 2-1. The Model 111TC Test Cable incorporates an AC line cord and plug and input and output cables and connectors.

2-11. MODEL 195 CABINET. When an amplifier is installed in the Model 195 Cabinet, connections between amplifier and cabinet are automatically effected by the Cannon connectors which are shown in Figures 1-1 and 1-5. Mating of these connectors thus brings amplifier input and output leads into properly shielded connection with INPUT and OUTPUT connectors on the small panel located below the amplifier opening on the façade of the Model 195 Cabinet (see Figures 1-3 and 2-3). An ON-OFF switch located between the INPUT and OUTPUT connectors controls power application to the amplifier and the blower in the cabinet.

2-12. The amplifier is held within the cabinet by an adjustable-pawl fastener on the lower front panel (see Figure 2-4). Turning the knurled shaft of the fastener one-quarter turn clockwise engages the catch behind the lip of the amplifier opening in the cabinet. By continuing to turn the shaft clockwise, the pawl is drawn toward the front of

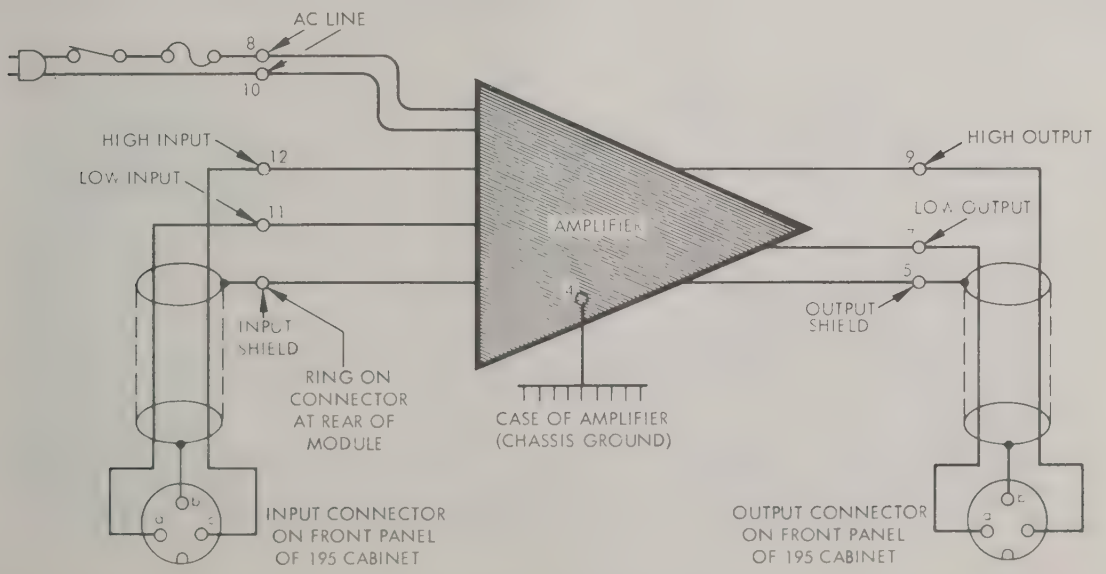


Figure 2-3. Amplifier Connections in Model 195 Cabinet

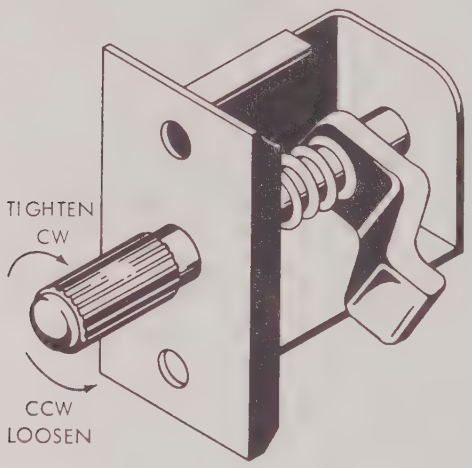


Figure 2-4. Adjustable Pawl Fastener

the unit, thus tightening the amplifier chassis within the cabinet and retarding internal movement. Although the amplifier will not be able to slip out of the cabinet while the pawl is engaged, it is advisable to tighten it snugly with the fingers to the point at which shaking the amplifier handle produces no movement of the amplifier within the cabinet.

2-13. Cable connectors which mate with the connectors mounted on the cabinet panel are furnished with the Model 195, and are shipped taped to the AC line cord of the cabinet. The connectors can be installed on the cabling intended for use in the installation.

2-14. MODEL 190 MODULE. As many as six Model 112A Amplifiers may be installed in a Model 190 module for rack mounting. Where fewer than six amplifiers are installed in a module, the vacant spaces MUST be filled by Model FP190 Filler Panels. Failure to maintain a closed facade in this manner will result in improper ventilation and shielding for the amplifiers.

2-15. Module and amplifiers are set up according to the following procedure:

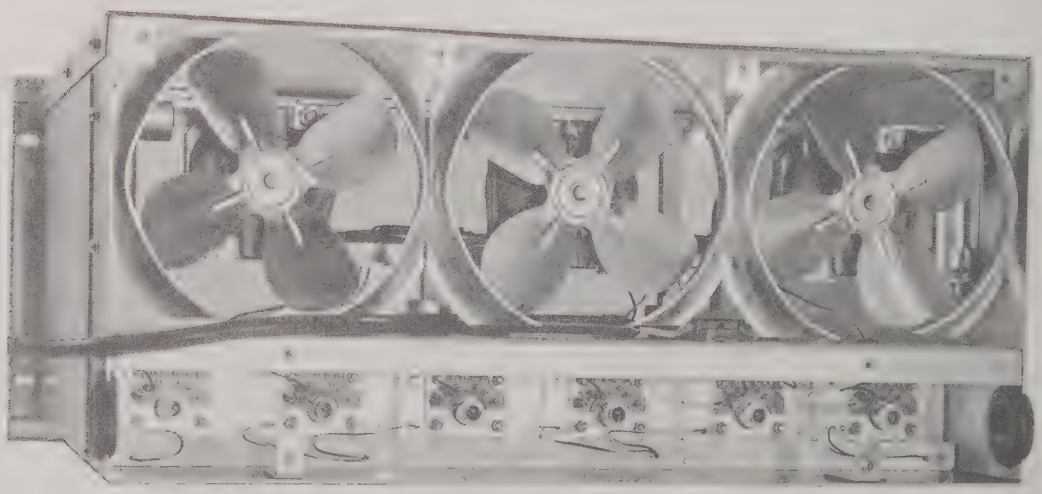


Figure 2-5. Rear of Model 190 Module, Cover Plates Removed

a. Place the Model 190 module on a bench, rear side out (see Figure 1-8).

b. Loosen the screws directly under the two outside fan vents. Remove the two screws immediately beneath. Remove the plate covering the bottom rear to expose the six amplifier connectors (see Figure 2-5).

c. Place the module on its side. Using a slot-blade screwdriver on the inside and a No. 4 nutdriver on the outside, remove the lower left (from the rear) screws and nuts which secure the notched metal places across the bottoms of each of the six amplifier connectors (Figure 2-6).

d. With the same screwdriver and nutdriver, loosen the remaining screws and nuts (lower right as viewed from the rear) which secure the notched plates (see Figure 2-6).

e. Grasp the left end of each metal plate and pull gently outward and downward, swinging into the position indicated by dashed lines in Figure 2-6.

f. Remove the fiber washers which encircle the Twin-ax connectors. These are the two-pin units which form pins 11 and 12 of the connector assemblies.

g. Using the end of the screwdriver, tap gently on the Twin-ax connectors from the front and pull from the rear. Remove the Twin-ax connectors; this will leave a hole through the center of each connector assembly.

h. Now remove Twin-ax covers: With the small end of a Twin-ax connector toward the disassembler, grasp the large end with thumb and fingers of the left hand so that the thumb touches the positioning or locator pin. The unlatched edge of the spring cover on the small end of the connector will be facing the disassembler. Place the right thumbnail against this edge and, with a sliding motion to the right, pop off the cover. The soldering terminals are now exposed.

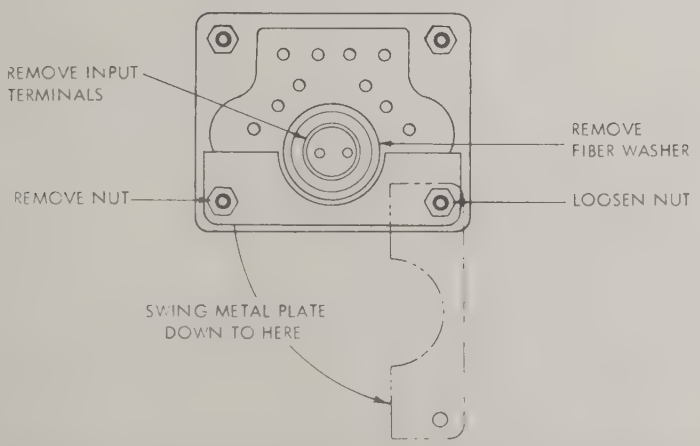


Figure 2-6. Housing-Mounted Amplifier Connector (Rear Detail)

i. Installation cabling must be threaded into the module through the chosen opening. (If a direct rear entrance is to be used, cabling must first be threaded through one of the openings in the panel removed in step "b."). Input leads must be tinned and shielding unbraided to allow optimum soldering neatness.

j. Using a small iron, solder the leads to the gold-plated terminals (Figure 2-7). Solder the shields to the rear of the connector bodies as shown in the drawing.

NOTE

To avoid "cold solder joints" it may be advisable to use a larger iron for the soldering of shields to connector bodies.

k. Replace Twin-ax connectors in their amplifier connector assemblies. Replace the fiber washers over the Twin-ax connectors. Swing the notched metal plates back into position and tighten right screw and nut. Replace left screw and nut.

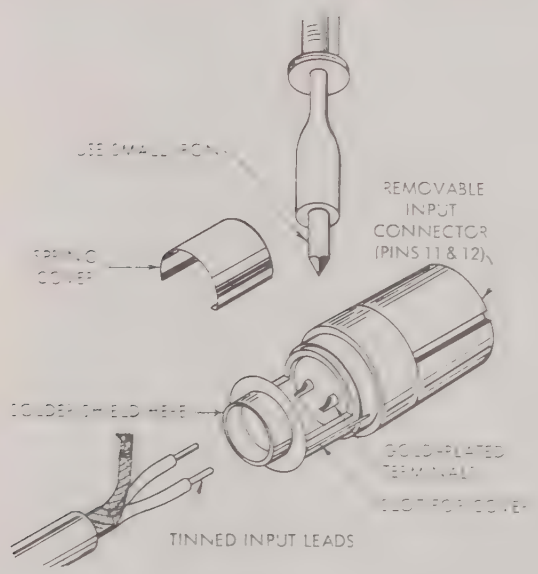


Figure 2-7. Twin-ax Connector Details, Showing Input Wiring

Table 2-1. Amplifier Connections

PIN	CIRCUIT CONNECTION
1	Signal circuit common
2	Shield of operational output
3	Operational output
4	Chassis
5	Output shield
6	Unused
7	Output return
8	115V AC
9	Signal output
10	115V AC
11	Input return
12	Signal input

l. Turn module face down on bench. Using a small soldering iron, attach output and ground leads (refer to Table 2-1).

m. Pick up module and insert it in the standard 19-inch rack, leading the AC cord and the input and output cabling ahead. Secure module to rack with four screws.

n. Insert amplifiers one-by-one into the module, aligning each by the respective guide strip on the module

floor near the rear (these tabs engage the mating slots in the bottom flanges of the rear amplifier panels).

o. Engage latches at bottom of each amplifier front panel by rotating the shafts of the adjustable-pawl fasteners (Figure 2-4) one-quarter turn clockwise. Continue turning shafts clockwise until finger tight. This pulls amplifier and module connectors snugly together and holds the amplifiers firmly in the module.

p. Insert any blank filler panels required to completely close the module facade if less than six amplifiers are installed.

2-16. If the amplifiers are to be used in conjunction with equipment already installed in the rack, it may not be feasible to wire input and output connections with the Model 190 module on the bench. In this case, the output connections should be attached first; then the Twin-ax connectors removed and input leads attached in midair behind the rack. Such installations will require the services of two persons: For removal and replacement of Twin-ax connectors, one must hold the screwdriver from the front and one must use the nutdriver from the rear; for cable connecting, one must hold the connector and wires and one must do the soldering.

2-17. SIMPLE OPERATIONAL TEST. Before wiring an intricate installation, it is well to make an initial breadboard-type amplifier connection and conduct simple tests of amplifier performance.

2-18. A simple operational test of the Model 112A Amplifier can be made with a single-cell battery and a standard voltmeter (Figure 2-8). If the Model 112A-A Function Plug-In is used, the procedure is as follows:

a. Switch on amplifier. The AC ON lamp should glow.

b. Adjust range switch for a gain of 20.

c. Connect the single cell to the amplifier input (disregarding polarity).

d. Measure the output voltage. If the input level is +1.4 volts, the output should measure -28 volts. If a -1.35 bias cell is used, the output should provide a +27-volt reading.

e. More exacting tests would follow the same configuration with increasing precision of setting and readings.

2-19. If a Function Plug-In other than Model 112A-A is used, the same type of test may be performed, with limitations imposed by the gain(s) available.

2-20 GROUNDING CONSIDERATIONS

2-21. Although details of input and output connections have been disclosed in the preceding paragraphs and in Table 2-1, bandwidth and gain of the Model

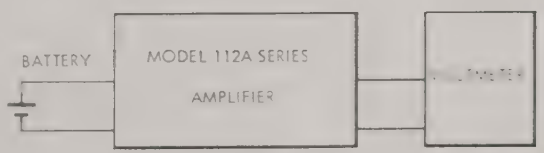


Figure 2-8. Operational Test Setup

112A may be sufficiently high to warrant special considerations when connecting into existing instrumentation equipment in certain installations. Use of a single Model 112A amplifier in close proximity to associated equipment will usually entail wiring of no more complexity than is shown in Table 2-1. However, many installations are vastly intricate and require precautions against such problems as noise, oscillation, and overload.

2-22. Usually an amplifier will have to be grounded at some point in the system. Internal or external connections from the common circuit to the case will provide grounding. But if the common circuit of the amplifier is grounded, and the signal source is also grounded, it becomes apparent that some amount of ground-loop current will be generated due to differences in potential (referred to as "common mode voltage") at the two points of grounding. (See Figure 2-9.)

2-23. FLOATING AMPLIFIERS. In floating amplifiers (Figure 2-10) circuit common is isolated from case or chassis ground. The effectiveness of this isolation is determined by the efficiency of internal shielding (including the individual shielding of transformers) as well as that of associated equipment. The Model 112A is such a floating unit, and incorporates shielding of such efficiency that isolation from ground is maximum obtainable for a single-ended amplifier.

2-24. BASIC GROUNDING RULES. For optimum low level operation, certain rules must be observed when making system grounding connections. The most basic of these is to keep ground loop current as low as possible, since it presents the greatest threat to sys-

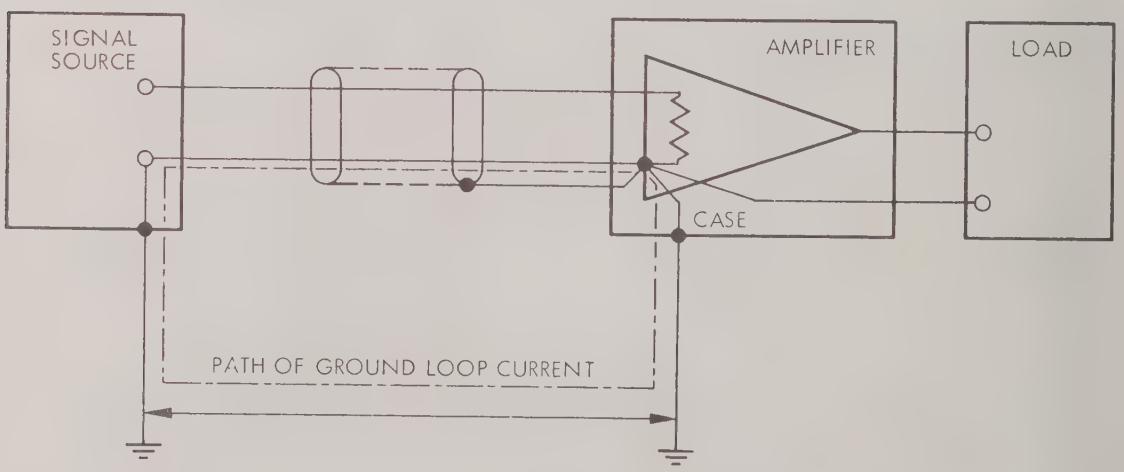


Figure 2-9. Ground Loop Current Generated in a System Where Amplifier and Signal Source are Both Grounded

tem performance (noise -- especially hum at the power line frequency). The next rule -- directly in relation to the first -- is to shunt such residual current away from lines which may be affected by it. Occasionally this may require relocating units of a system to obtain the best routing of cables, but such steps pay off in extra performance at low levels.

2-25. Generally, installation grounding will be a straightforward procedure governed only by the basic grounding rules. Because of the individual nature of each installation, the application of these rules may be limited by any of several factors. In certain systems, accuracy and resolution are degraded by noise arising from the necessity of using long lines between signal source and amplifier or between amplifier and load, or both. Under adverse conditions, such noise could be many times greater than the minimum signal from the source. Further complications can be presented by capacities of cables and shields.

2-26. AMPLIFIER LIMITATIONS. If the configuration of a system is such that judicious application of good grounding techniques does not reduce common mode voltage to an optimum level, the installation may require characteristics not found in a single-ended amplifier. In such cases, the problems can be surmounted by the use of the KIN TEL Model 114A Differential DC Amplifier.

2-27 SHIELDING CONNECTIONS

2-28. When connecting input or output cable shields, a prime consideration is the nearest possible approach to a unipotential surface for shielding. Therefore, a shield must be connected at one point only. For most installations, there is a basic connection layout which should serve to provide proper shielding and grounding with a minimum of inconvenience and time loss due to subsequent system changes.

2-29. INPUT SHIELD. The shielding integral with the input cable should

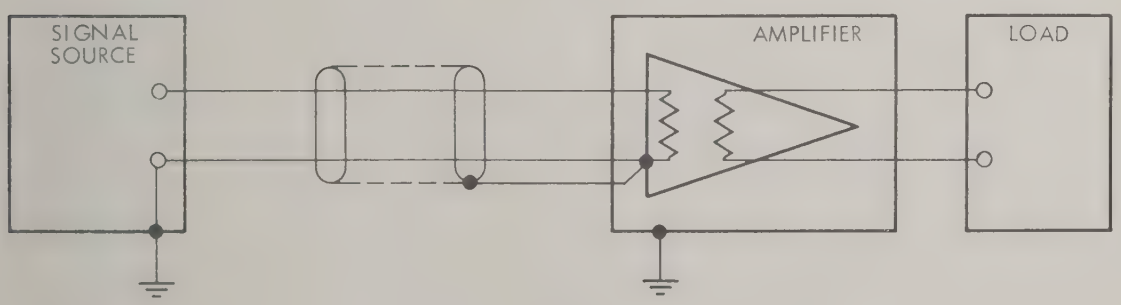


Figure 2-10. Minimizing Ground Loop Current in a Grounded-Source System through the Use of a Floating Amplifier

contact ONLY the body of the Twin-ax input connector to which it is soldered (as described in paragraph 2-15, step "j"). (See Figure 2-7.) Such connections must be made only for the Model 190 module. When the amplifier is installed in the Model 195 Cabinet, the input cable shield must be wired to the input cable connector furnished with the cabinet so that it contacts pin "b" of the INPUT connector (upper center pin of the connector at lower left corner of the cabinet front). (See Figure 1-5.)

2-30. OUTPUT SHIELD. When installed in the Model 195 Cabinet, the amplifier output shield becomes automatically connected to pin "b" of the OUTPUT connector (upper center pin of the connector at lower left corner of the cabinet front). (See Figures 1-5 and 2-3.) When installed in the Model 190 Module, amplifier output shields are automatically connected to pin 5 of the respective module connector assemblies. (See Figure 2-11.) In any installation where system input and output shields are isolated from each other and from conduits or other ground, the amplifier output shield connection may be continued through to the device into which the amplifier operates.

2-31. Where the installation is more complex, possibly involving the common grounding of input and output shields, resulting ground loops can increase noise and hum and even introduce amplifier oscillation. To avoid these ground loops in circuits involving the Model 190 module, connect the output shield to the low side of the output terminal (pin 7), as in Figure 2-12. In the Model 195 Cabinet, the shield of the inner output cable (which runs from the amplifier connector to the OUTPUT connector on the cabinet) must be unsoldered from pin "b" of the OUTPUT connector and soldered to pin "a" (which is also the terminal for the low side of the output cable).

CAUTION

Only insulated cables should be used for all wiring, to avoid accidental contact of shields with each other or with chassis ground.

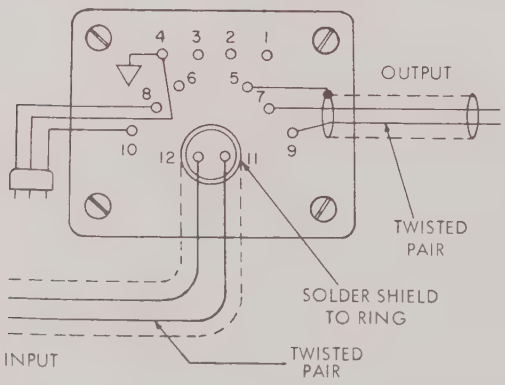


Figure 2-11. Amplifier Connections in Model 190 Rack Module

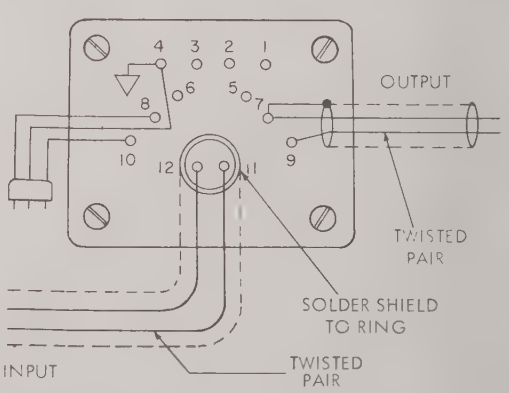


Figure 2-12. Wiring of Amplifier Connections to Avoid Ground Loops

2-32. OUTPUT CAPACITY. The load placed on the amplifier output becomes a part of the inverse feedback circuit; consequently, load characteristics affect the nature of the feedback signal. High capacitive loading of the output circuit can degrade amplifier stability -- even to the point of oscillation -- and increase the time required for recovery from overloading.

2-33. The output capacity specifications for the Model 112A (as noted in Table 1-1) will be determined by the nature of the specific function plug-in being used. When the Model 112A-A Function Plug-In is used, the amplifier will operate within performance specifications while load capacity is as great as 0.5 microfarad.

2-34. Some compensation can be made for highly capacitive loading with little or no effect on most other operating characteristics. One counter-measure is the strapping of the output with a resistance. In cases where this does not prove completely effective, a capacitive voltage divider may be placed in the output line.

2-35. Figure 2-13 illustrates the configuration of a voltage divider which may be used with high-capacity loads. Circuit constants will be determined by the impedance of the output load; divider values will be determined by capacitance of load and cable and by load resistance.

2-36. The series capacitor C_1 in Figure 2-13) should be selected to provide a total series capacitance (C_1 and CC) not to exceed 0.2 microfarad. Following is the specific procedure:

a. With a "Q" meter or impedance bridge, measure the total capacitance of load and cable.

b. Select C_1 to equal

$$\frac{CC}{5\,CC - 1}$$

2-37. The selected series resistance (R_1 in Figure 2-13) must have a ratio to the load resistance (R_L in Figure 2-13) which is equal to the ratio of the reactances in the capacitive divider. Following is the specific procedure:

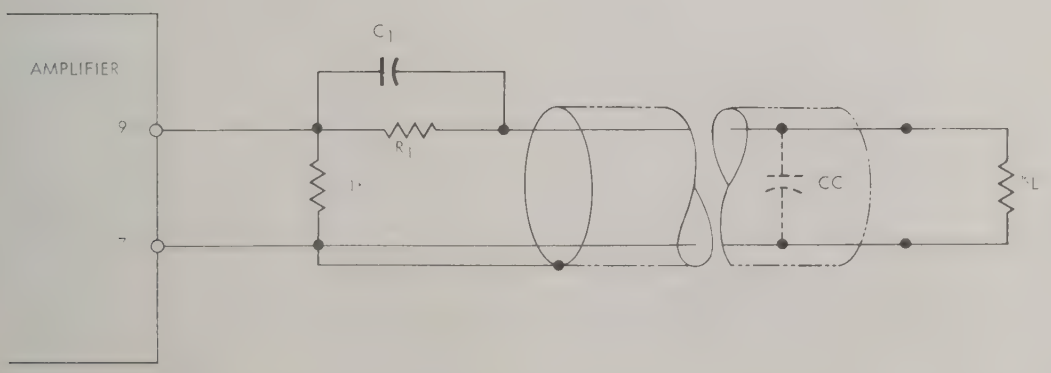


Figure 2-13. Configuration of Voltage Divider Setup for High-Capacity Loads

a. Determine R_L

b. Select R_1 to equal

$$\frac{R_L \times CC}{C_1}$$

2-38. VENTILATION. The front panel of the Model 112A amplifier is slotted to provide an intake vent for cooling air. The fans mounted in the rear of the housings (one in the Model 195 Cabinet and three in the Model 190 module) draw the air through the intake vent and across the upper part of the amplifier chassis, exhausting it through grilles at the rear.

2-39. The ventilation facilities of the housings are designed to provide a specific volume of cooling air at a specific rate. Optimum air movement results in optimum amplifier performance. Do not allow intake slots to be covered with calibration tags or stickers or any other objects which might reduce air intake. Further care should be taken to allow adequate space behind cabinet or rack installation for exhausting the heated air.

2-40. If other equipment is installed in the same module with amplifiers, it must be placed so that it neither impedes the flow of air nor invalidates the ventilation design by allowing excess air to be drawn into the module at a point other than the intended intake vents. The recommended procedure for such installations is to place such other equipment behind Model FP190 Filler Panels (refer to paragraph 1-26).

2-41 OPERATION

2-42. The Model 112A Wideband DC Amplifier is operated in a clear and straightforward manner. Application of AC line voltage by connecting the line cord of the associated housing to a nominal 117-volt source (and -- when the Model 195 Cabinet is used -- switching the AC switch to the ON position) will cause the front panel AC ON lamp to glow. (See Figure 2-14.)

2-43. Allow the amplifier to warm up for at least 30 minutes for optimum results. If the Function Plug-In being used incorporates a variable gain control, setting is then made for the desired gain range.

2-44. VERNIER GAIN CONTROL. To obtain gain as set by the configuration of the Function Plug-In, the VERN. GAIN control (screwdriver-adjustable pot accessible through the extreme right aperture just below the air intake slots and just above the panel handle) must be set in the extreme counterclockwise position. (See Figure 2-14.) If desired, the set gain may be increased to as much as twice that determined by the Function Plug-In by rotating the VERN. GAIN pot clockwise.

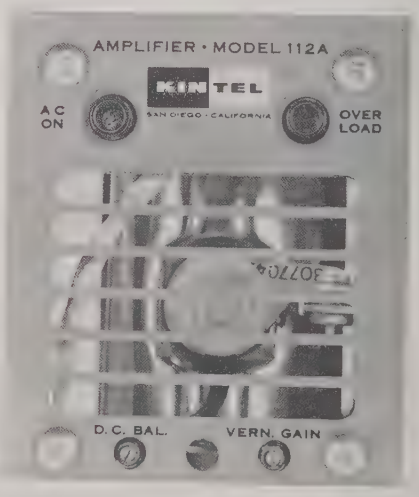


Figure 2-14. Integral Front Panel, Showing Controls

2-45. "MICRO-GAIN" CONTROL. In most Function Plug-Ins, an additional control is provided to allow for extremely critical gain adjustment. This Micro-Gain feature should not be considered a standard control. It is adjusted at the factory under test conditions and may perhaps never be readjusted during the life of the instrument in an average installation. For this reason, although it is readily accessible through its front-panel aperture (Figure 2-15), the Micro-Gain control is not identified by front panel callout.

2-46. In certain applications, the need may arise for a gain setting of particularly fine accuracy. In such an installation, the Micro-Gain control will provide a precision gain setting beyond a normally measurable accuracy, since the Micro-Gain control is in series with the feedback resistors. To increase gain, rotate control CW; to decrease gain, rotate CCW.

2-47. DC BALANCE ADJUSTMENT. After the amplifier has been installed and turned on for the required warm-up period, it may be balanced for zero output with zero input. The procedure is as follows:

a. Short the amplifier input.

b. Connect to the amplifier output a high-accuracy DC microvoltmeter (such as the KIN TEL Model 202B) with sensitivity set on the 10-millivolt range. Allow microvoltmeter to warm up for the required period.

c. If the microvoltmeter does not read zero, adjust the DC BAL. control (Figure 2-14) on the upper front panel of the amplifier until a zero reading is obtained.

2-48. After initial balance adjustment, subsequent zero-balancing is seldom required unless amplifier operating conditions are altered by environmental change, such as moving the amplifier into a different housing or effecting drastic change in ambient temperature of the installation. In re-balancing the amplifier, the indicating device should be of high sensitivity, due to the very low drift specifications of the Model 112A.

2-49. FUNCTION PLUG-INS. The Model 112A-A is the most widely used of all the Function Plug-Ins, due to its versatile gain range. (See Figure 2-15.) Available on special order are plug-in units which allow the Model 112A to perform a multitude of functions. The removal and replacement of these modular attenuators is simply and easily effected:

a. Loosen adjustable-pawl latch at bottom of amplifier panel by rotating it counterclockwise until pawl disengages lip of housing.

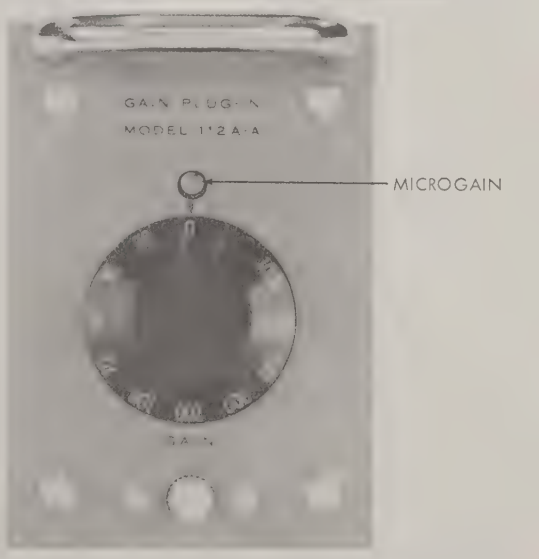


Figure 2-15. Plug-In Front Panel, Showing Controls

b. With Phillips screwdriver, loosen the four 6-32 x 5/8" screws at the corners of the lower panel section until they disengage the threads in the amplifier chassis. As shown in Figure 2-16,* these screws are retained by rubber grommets on the back side of the panel; this permits loosening of the screws without the necessity of removing them.

c. Grasp the amplifier handle and withdraw the plug-in module from the amplifier.

d. Replacement of any module will consist of reversing the removal procedure. Be certain that normal torque is applied to retaining screws and to the adjustable-pawl latch shaft.

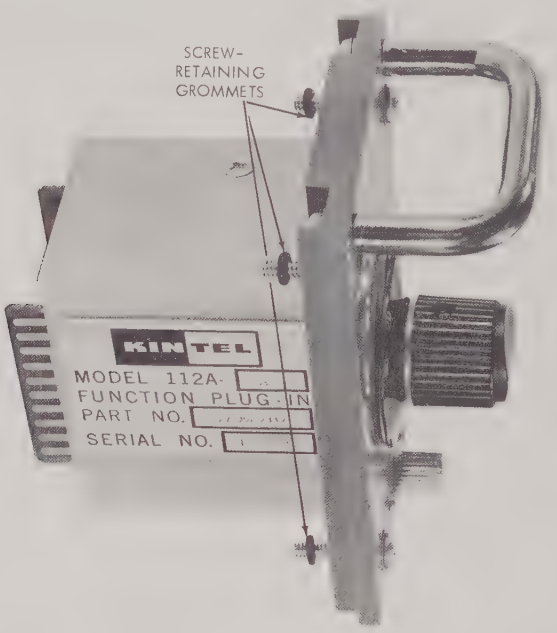


Figure 2-16. Function Plug-In Removed from Amplifier Assembly

*Illustrated is the Model 112A-A; general conformation and procedure are the same for all models.

Section III
THEORY OF OPERATION

3-1 OVERALL FUNCTION

3-2. The overall function of the Model 112A Wideband DC Amplifier is to provide precisely known gains for minute direct currents having AC components extending into and beyond the range of audibility. This is accomplished by the combined circuitry of three special amplifiers ($+K_1$, $+K_2$, and $-K_3$ in Figure 3-1).

3-3. The first two amplifiers ($+K_1$ and $+K_2$) are paralleled and receive the same input signal.

3-4. $+K_1$ is a wideband amplifier circuit which accepts only AC components of the signal; direct currents are blocked by a capacitor. The AC components are amplified (without change in polarity) and applied to a summing junction ($\otimes$).

3-5. $+K_2$ is a chopper amplifier circuit which accepts only DC and very low frequency components, which are amplified (without change in polarity) and applied to the same summing junction as the output of $+K_1$. The positive sign is used to indicate that $+K_1$ and $+K_2$ do not alter signal polarity. This common feature permits the output of these two amplifiers to combine before final signal amplification.

3-6. The combined signal from the first two amplifiers is applied to the third (designated $-K_3$ to show the polarity and phase reversal which occurs between the input and output of this circuit). This final amplifier acts on all components of the signal: DC, very low frequencies, and AC through the audio range and beyond. The alteration of polarity and phase provides a degenerative characteristic in the overall feedback, resulting in optimum stability of the instrument. Impedance of the output amplifier circuit is very low, allowing considerable loading by such metering or recording devices as are required by the installation with no significant effect on signal characteristics or amplification.

3-7. The output signal is also tapped off in a voltage divider and applied as inverse feedback to the amplifier input. Varying the selection of the available constants in this voltage divider changes the proportion of the output signal fed back to the input. The resulting change in degeneration consequently alters the amplification. Available feedback constants are predetermined by the choice of plug-in attenuators (Function Plug-Ins), which provide fixed amplifier gain(s) as marked. With any plug-in, the total amount of feedback applied around the

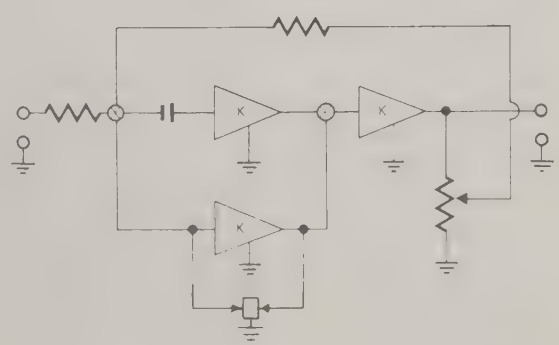


Figure 3-1. Basic Block Diagram of Model 112A Wideband DC Amplifier

circuit is sufficient to eliminate amplifier sensitivity to variations in power line voltage or to alterations in vacuum tube characteristics due to aging.

3-8 DETAILED OPERATION

3-9. The Model 112A Wideband DC Amplifier incorporates six amplifying stages, an output bridge, a chopper, a driven-diode demodulator, a feedback network, and a power supply (Figure 3-2). The arrangement of these elements permits only AC components to be amplified in a high frequency amplifier ($+K_1$), only DC and very low-frequency components in a paralleled amplifier ($+K_2$), and the reconstituted signal (combined outputs of $+K_1$ and $+K_2$) in a final amplifier ($-K_3$).

3-10. The input signals applied to the Model 112A are fed to a summing junction (SJ1). This junction -- not a circuit component -- is simply a connecting point for the application of inverse feedback and input signals and a distribution point for the signals being fed to the high frequency amplifier ($+K_1$) and the DC and low-frequency amplifier ($+K_2$).

3-11. HIGH FREQUENCY AMPLIFIER. The high-frequency amplifier ($+K_1$) receives signals at frequencies higher than one cycle per second; lower frequencies are blocked by C318 (Figure 3-2). The hf amplifier consists of V301A (one triode section of a high-mu duotriode 5751) and -- through capacitive coupling -- V302 (a high-gain pentode 6AU6).

3-12. Summing Junction SJ2 (another junction point -- not a circuit component) is located between the two stages of amplification. Rectified signals from the DC and low frequency amplifier are applied here to provide an operating reference, to stabilize the hf amplifier, and to reduce the time required for the instrument to recover from possible overloading. The output of V302 is coupled by C316 to SJ3 -- a third junction point.

3-13. DC AND LOW FREQUENCY AMPLIFIER. The input signal appearing at SJ1 is applied through R317 to pin 3 of the chopper (D101) and to the input of the DC and low frequency amplifier. The chopper "grounds" this signal 60 times each second, transforming the DC into a modulated 60-cycle carrier which can be amplified for subsequent demodulation.

3-14. After amplification in V301B (second half of the high-mu duotriode 5751) and V304 (a high-gain pentode 6AU6), the chopper-modulated carrier is isolated from circuit common by coupling capacitors. The other chopper contact (at chopper-pin 5) is used for synchronous rectification of the signal which appears at pin 5 of V304. The resulting demodulated signal is applied through R331 to Summing Junction SJ2 as stated in paragraph 3-12. The carrier -- not materially affected by this tapping off of a stabilizing signal -- is further amplified in V305 (a second high-gain pentode 6AU6), then synchronously rectified by driven-diode demodulators CR309 and CR310. The resultant DC output is applied to SJ3, where it is combined with the AC components amplified in V301A and V302.

3-15. OUTPUT AMPLIFIER. The reconstituted signal appearing at SJ3 is applied to the output amplifier which

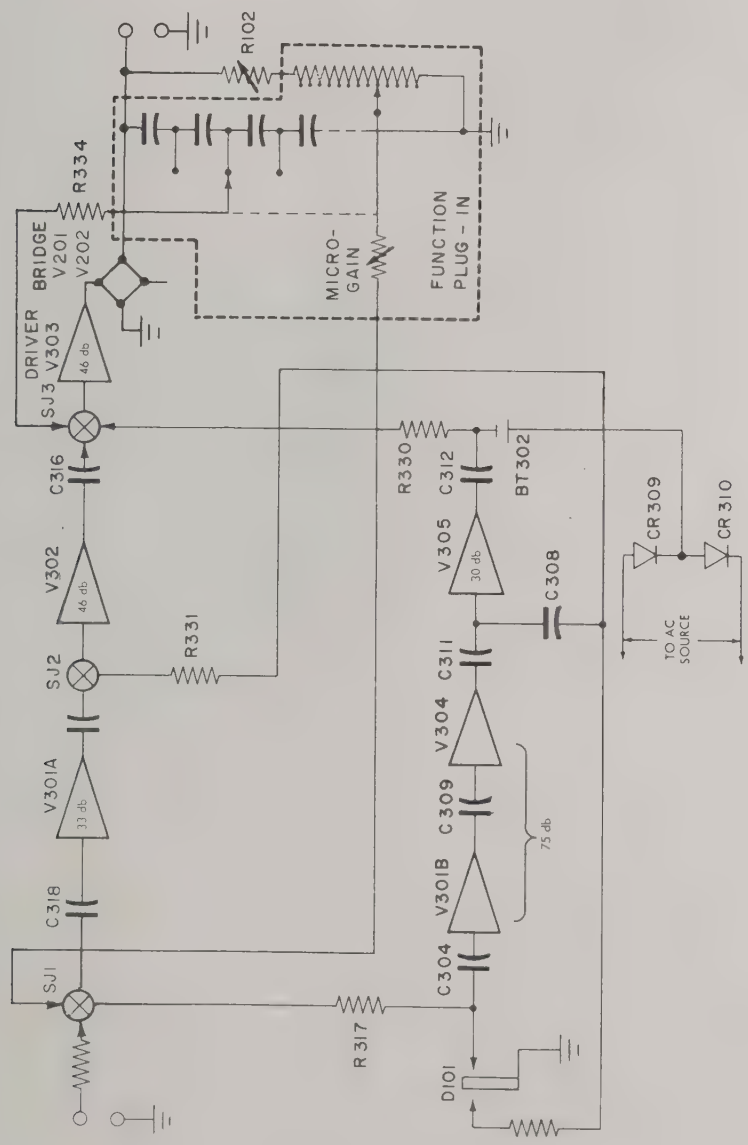


Figure 3-2. Circuit Configuration of Model 112A Wideband DC Amplifier

consists of output-driver V303 (a high-gain pentode 6CB6) and a bridge circuit employing two 6BX7GT duotriodes (V201 and V202). After amplification in the previous amplifier circuits, the signal is so large that noise, hash, and drift (which are inherent in traditional DC amplifiers) cannot affect the signal beyond a negligible degree; consequently, both DC and AC components are amplified in V303. During amplification in this output stage, the DC signal polarity is reversed and the AC signal phase is inverted.

3-16. The signal from the output driver is applied across the output bridge, which is balanced against common with zero signal. The bridge output -- which is the output of the Model 112A amplifier -- has an impedance of less than 1 ohm. The output may be either positive or negative, depending inversely upon the polarity of the input signal to the Model 112A.

3-17. FEEDBACK NETWORK. At the output of the bridge, a resistive-and-capacitive voltage divider (the chosen Function Plug-In) taps off two signals which are fed back to SJ1 and SJ3. Overall feedback to SJ1 is determined by the resistive voltage divider only; this loop is therefore not frequency selective, but controls overall gain of the Model 112A. The signal tapped off at the RC divider for application through R334 to SJ3 determines frequency response and simultaneously stabilizes the direct-coupled stages in the output amplifier (V303, V201, and V202). The overall feedback loop (fed to SJ1) includes the VERN. GAIN control described in paragraph 2-44.

3-18 CIRCUIT THEORY

3-19. To clarify specifically described circuit details, particularly those not common to conventional DC amplifiers -- including features exclusive and proprietary to the Model 112A -- reference may be made to the schematic diagrams in the back of this manual.

3-20. HIGH FREQUENCY AMPLIFIER. AC components of input signals fed to the Model 112A are first amplified by V301A, then (through coupling capacitor C307) applied to V302. Both of these stages are conventional wideband amplifiers.

3-21. In the event of high frequency over-voltage application, or in the presence of high-frequency signal amplitudes exceeding approximately 60 volts at V302 plate, the amplifier tends to become a non-linear oscillator.

3-22. To provide instant return to normal after such transients, VR301 (an NE2) is included in the circuit. If V302 plate exceeds approximately 60 volts, the NE2 ignites, providing a discharge path to common for C316.

3-23. CHOPPER AMPLIFIER. A feature common to all KIN TEL Wideband DC Amplifiers is the use of a chopper or signal modulator with a narrow-band 60-cycle amplifier to permit handling of direct currents without the noise and drift commonly associated with DC instrumentation. Basically, the chopper* is an oscillating reed which vibrates at a frequency determined by the application of a nominal voltage to a drive-coil. Contacts at either end of the oscillation path are connected and disconnected at the predetermined frequency. Thus a DC signal applied to one contact may be "grounded" each half-cycle, converting the originally smooth potential into

*Recommended reference: "Chopper Checkout Procedure for KIN TEL Equipment" (Publication Code No. 13-57).

a pulsating DC signal. The quality choppers employed by KIN TEL furnish a precise 60-cps signal (due to their 60-cps drive voltage), having a square-topped waveform as shown in Figure 3-3.

3-24. The 60-cps signal from the chopper is amplified in a capacitance-coupled circuit which removes any reference to common, changing the pulsating DC to AC. The output of V304 (simplified in Figure 3-3 as a triode) is in phase with the input signal to V301B. However, the output signal from V304 (after smoothing by C308) is "grounded" by the chopper reed on alternate excursions, thus the amplified signal is tied to common at the top (if input signal polarity is as shown; in the case of a negative input signal, the output waveform from V304 would be tied to common at the bottom). This DC signal is applied to SJ2 (as described in paragraph 3-12), where it is combined with the output signal from V301A, with which it will always agree in polarity. (Polarities of these two signals will always be opposite that of the input signal to the Model 112A.)

3-25. The output of V304 is also applied to V305 for further amplification. The amplified AC signal is then demodulated and applied to SJ3, where it is mixed with the output of the hf amplifier for application to the output driver stage.

3-26. SIGNAL PATH. As shown in Figure 3-3, output capacitor C308 is shorted to common when the input grid is open, and input capacitor C304 is shorted to common when the output plate is open. At the moment of consideration, no DC is applied to C304. With no input signal, there is of course no output signal at the plate of V304 (C308 remains essentially charged to the V304 no-signal plate voltage, and has an extremely slow discharge path through the output circuit while the chopper reed is at pin 3.

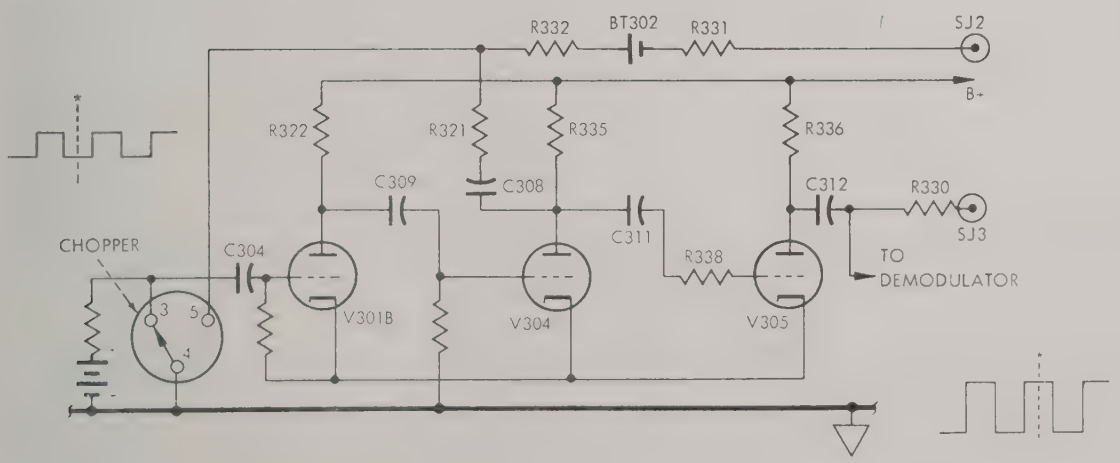


Figure 3-3. Chopper Amplifier Configuration: Moment of Input Grounding

3-27. Assume the V304 no-signal plate voltage (to which C308 charges) to be 125 volts; assume further that a positive DC signal (represented in Figure 3-3 as a battery with a current-limiting resistor) is applied to the chopper amplifier: With the reed at pin 3, input is at common and no signal reaches the amplifier. With the reed at pin 5, the signal reaches the amplifier with the following results: V301B grid swings positive, V301B plate becomes less positive, V304 grid becomes negative, and V304 plate swings positive.

3-28. Assume that V304 plate goes from 125 volts to 135 volts: With the reed at pin 5, C308 is at common and quickly charges to the higher V304 plate voltage of 135 volts through R335, but no voltage is coupled to the output (now at common). When the reed swings to pin 3, input is at common, V304 plate voltage decreases to its no-signal value of 125 volts and V304 output is "ungrounded". Since C308 is now charged to 135 volts and has no quick-discharge path, the decrease in plate voltage is coupled to the output, changing it from 0 volts to -10 volts. It can be stated, then, that the output voltage equals the V304 no-signal plate voltage (125 volts with chopper reed at pin 3) minus the V304 signal plate voltage (135 volts with reed at pin 5) 125 volts minus 135 volts equals -10 volts. This prevails regardless of the polarity of the amplifier input signal.

3-29. For example, with a negative input to the amplifier, V304 plate voltage would have been lower (assume 115 volts) at the moments when the chopper reed was at pin 5, and C308 would have discharged quickly through R321 and the output chopper to this value. Again, the output equals the V304 no-signal plate voltage (125 volts with chopper reed at pin 3) minus the V304 signal plate voltage (115 volts with chopper reed at pin 5): 125 volts minus 115 volts equals +10 volts.

3-30. In recapitulation, it is apparent that chopper action serves to tie the output wave to common so that a useful DC may be obtained. When the input signal is positive as in Figure 3-3, the chopper ties the top of the output waveform to common, providing a negative, pulsating-DC output. With a negative input signal, the chopper ties the bottom of the output waveform to common, resulting in a positive, pulsating-DC output.

3-31. DRIVEN DIODE DEMODULATION. As shown in Figure 3-2 and described in paragraph 3-14, the filtered AC output signal from V305 (third stage in the chopper amplifier) is applied to SJ3 as a smooth DC signal having the same polarity as the input signal to the Model 112A. This is accomplished by a driven diode demodulator network which is illustrated in Figure 3-4.

3-32. Diodes CR309 and CR310, as shown in the diagram, are arranged essentially in a bridge circuit. At the half-cycle under consideration, the diodes conduct, unbalancing the bridge. The diode junction (X) is then at approximately the same potential (amplifier circuit common) as the junction of R343 and R344. The waveform is thus clamped to common at the moment indicated by the dotted line and asterisk.

3-33. The remaining 60-cps signal is smoothed by the filtering action of series resistor R330 and the combination of C316 and V302 plate impedance. The application level at the grid of V303 is nominally as shown by the dashed

line in the waveform at the lower right corner of the illustration. As stated in paragraph 3-5, the polarity at the final output of both the chopper amplifier and the hf amplifier (SJ3) is always the same as the polarity of the input signal to the Model 112A.

3-34. OUTPUT DRIVER STAGE. The reconstituted signal at SJ3 is fed to the grid of V303 (a conventional DC amplifier pentode 6CB6). This stage inverts the signal (as mentioned in paragraph 3-6) to provide the degenerative characteristic required for overall feedback in the Model 112A. To avoid the loss of high frequency components, the output of V303 is taken from a voltage divider (R201 and R202), the series arm of which (R201) is shunted with a capacitor (C203). The values selected furnish a mild boost.

3-35. OUTPUT BRIDGE CIRCUIT. The combined outputs of the hf amplifier and the chopper amplifier -- after final amplification by V303 -- appear across a balanced output stage which is a bridge circuit employing one-half of a duotriode in each of the four sides, with the load connected across the "bridge" in the position normally occupied by a null indicator. (See Figure 3-5).

3-36. This arrangement provides a balanced output which is capable of a full range of current through the load in either direction. The bridge is so arranged that the total current drawn by the power supply remains almost constant in the presence of signal fluctuations, unless an excessive input signal results in an overload. This feature is due to the independent power supply for the stage -- which provides a floating B+ of 200 volts and a floating negative voltage of -150 volts, with circuit common connected only by conductance of the tubes -- and to the resistors chosen to provide precisely proportional changes in plate current.

3-37. With no signal applied to the input of this stage, plate currents of all four triode sections are equal. Thus

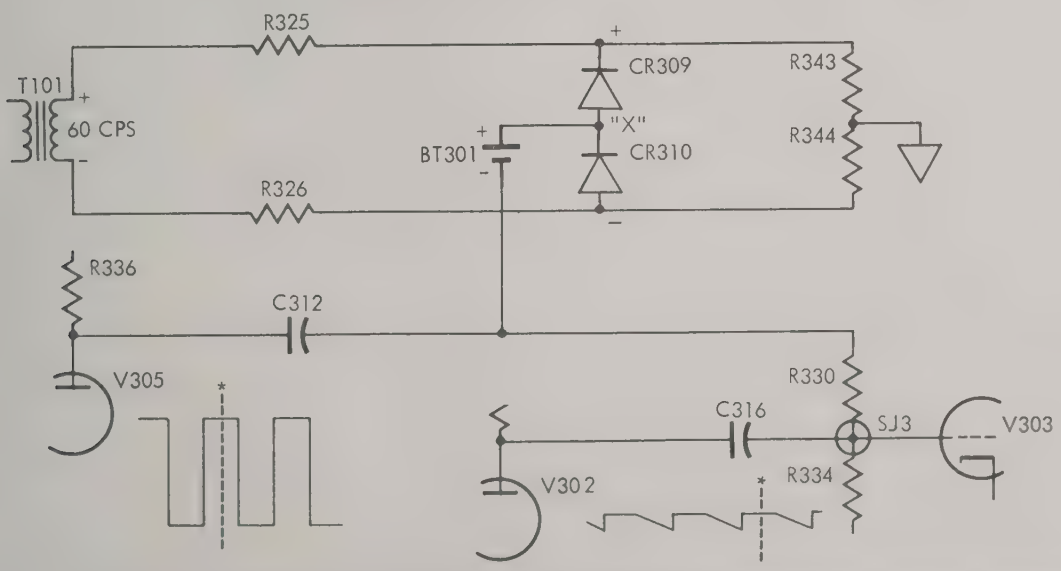


Figure 3-4. Driven Diode Demodulator Circuit (refer paragraphs 3-31 -- 3-33)

voltage at point "A" is equal to that at point "B" (or, since point "B" is circuit common, zero voltage).

3-38. Any signal applied to the input will be coupled to the control grids of all four triode sections, and consequent changes in conductance will unbalance relationships of voltage and plate current throughout the entire stage. The voltage at point "A" must then change with respect to common, resulting in an output which is in phase with the input signal. As an example, assume a positive signal is applied to grid-pin of V201A: The plate current increases, resulting in a decrease of voltage at plate-pin 2. This decrease is coupled to grid-pin 4 of V201B through R208, with resultant decrease of plate current and corresponding increase in voltage at plate-pin 5 of V201B. This voltage increase is coupled through R212 to grid-pin 1 of V202B. When the initial signal was applied, the negative swing at plate-pin 2 of V201A was also coupled to grid-pin 4 of V202A.

3-39. The application of a positive-going signal has increased plate current through V201A and V202B, and decreased plate current through V201B and 202A, thus swinging the high side of the load in a positive direction, allowing current to flow through the load from common. If the application of a negative-going signal to grid-pin 1 of V201A is analyzed in the same manner,

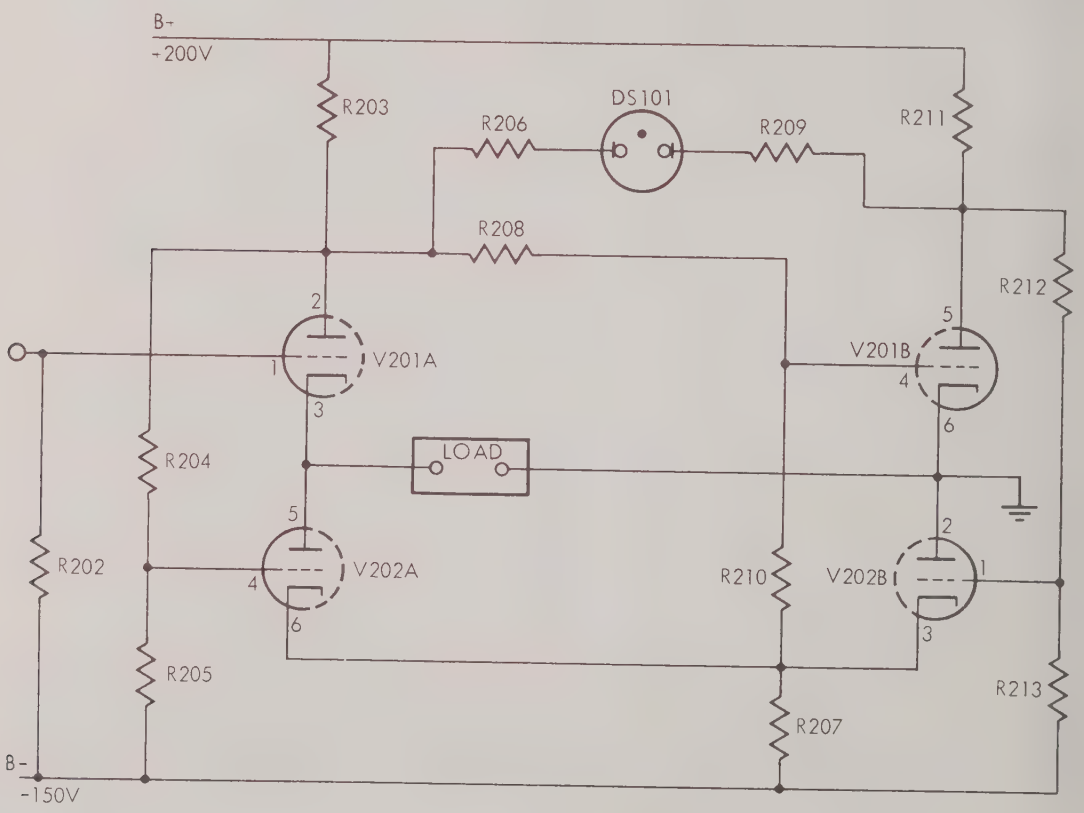


Figure 3-5. Output Bridge Circuit (Basic Configuration)

it is evident that the resulting output voltage would be negative, since current would flow through the load to common.

3-40. C203 and R201 determine bandpass characteristics of this stage (R201 also serves, with R202, in a voltage divider to furnish grid bias for V201A). R206 and R209 are current-limiting resistors which determine the amount of imbalance which can be tolerated in the output stage before overload indicator DS101 becomes energized. The un-bypassed cathode resistor for V202A/B also serves to stabilize the circuit. C204 and C206 provide proper bandpass characteristics for the higher frequencies.

3-41. OVERLOAD INDICATOR. Neon lamp DS101, shown schematically between the plates of V201A and V201B, is physically located on the front panel of the amplifier assembly.

3-42. Under signal conditions which increase the plate potential of V201A and decrease the plate potentials of V201B, a voltage -- attenuated by R206 and R209 -- is developed across DS101. The lamp (an NE 2A) will begin to glow as soon as the voltage difference between the plates reaches the lamp's ignition potential. This indicates that the voltages in the amplifier are near their safe maximum value.

3-43. The overload indicator operates, then, NOT to indicate that an amplifier is overloaded, but to show that an overload condition IS BEING APPROACHED.

3-44. DC BALANCE CIRCUIT. A voltage-dropping network is placed between the +200 and -150 volt lines to the output bridge. (See Figure 3-6.) A miniature balance pot (physically located on the front panel of the amplifier) selects from the network a voltage which is somewhere in the range from +0.3 to -0.35 volts. This signal -- after further attenuation -- is applied to the input (pin 3) of the chopper, thus correcting any offset which might originate in the input circuit. This control is identified as DC BAL on the front panel of the amplifier.

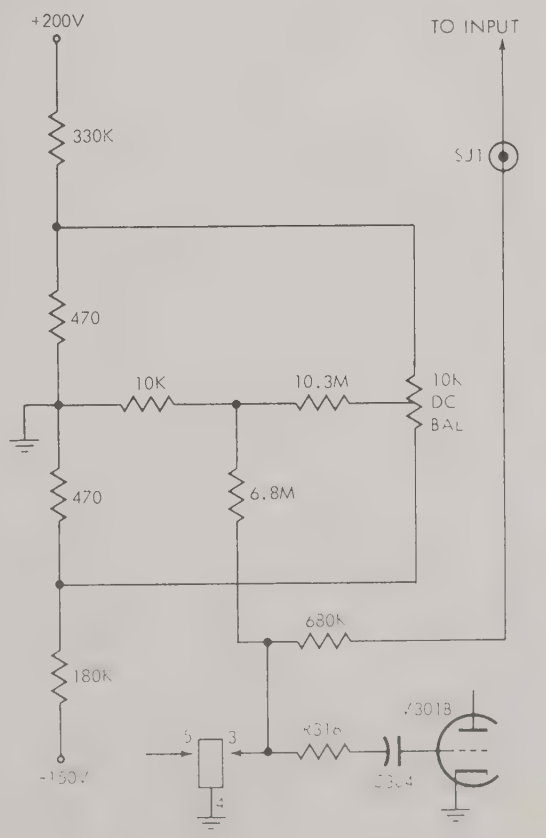


Figure 3-6. DC Balance Circuit

Section IV
MAINTENANCE

4-1 INTRODUCTION

4-2. Precision circuit design and the use of quality components well within the component manufacturers' rated safety margins have served to minimize, in the Model 112A, the maintenance problems normally associated with electronic equipment. As with any precision instrument, certain prescribed procedures and precautions must be followed to obtain maximum benefits from the precision of which the instrument is capable.

4-3. Maintenance should be performed only by qualified, trained technicians. The intricacy of precision amplifier circuitry is such that severe damage may result from repair activities attempted by untrained personnel.

4-4 PREVENTIVE MAINTENANCE

4-5. GENERAL. Periodic cleaning and inspection should be scheduled to prevent the accumulation of dust, lint, or other airborne pollution which might be detrimental to operation. The use of forced-air cooling will engender such accumulation, since large amounts of the ambient atmosphere are forcibly drawn past the inner chassis of the instrument.

4-6. If the installation area is air conditioned, atmospheric pollution will be minimized; however, the cleaning of grilles, modules or cabinets, and amplifier chassis should be scheduled after each approximate 2000 hours of operation until the optimum time lapse between cleanings can be determined by actual visual inspection.

4-7. FAN MOTOR LUBRICATION.* The motors used in the blower assemblies of Models 190 and 195 amplifier housings should be lubricated immediately following each cleaning operation. See Figure 4-1. It is extremely important that the proper lubricant (Shell Oil Co., Tellus No. 33) be used on these motors. Since the bearings are of a porous material (so designed to regulate oil flow to the motor shaft), oils having a lacquer base may congeal in the presence of heat generated by motor operation, thus forming a coagulant which would inhibit oil flow.

4-8. Clogged bearings will necessarily reduce motor speed and may lead to intermittent operation or may even progress to a state of complete inoperation. Since amplifier stability may be impaired by improper ventilation, the motor assembly must be completely cleaned to restore original operating conditions. Refer to paragraphs 4-23 through 4-28 for detailed procedure.

4-9. ETCHED BOARD HANDLING. Every precaution should be taken in handling etched and printed circuitry

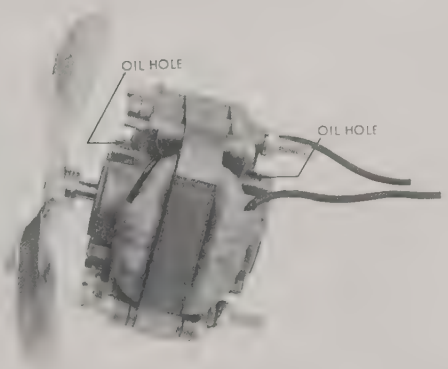


Figure 4-1. Blower Lubrication

*Later model housings (such as the Model 190A) employ fans which require no lubrication or disassembly.

while servicing. Boards may be contaminated by salts and acids present in the human skin (as well as by soldering fluxes other than pure rosin). Such contamination can lower leakage resistance between paths or components mounted on the boards. It is advisable to wear clean, cotton gloves when it becomes necessary to handle such circuitry.

4-10 CORRECTIVE MAINTENANCE

4-11. The removal and replacement of components mounted on etched or printed boards (Figure 4-2) must be executed with constant regard for thermal and mechanical considerations. The iron used to solder and unsolder connections should be kept at the low-

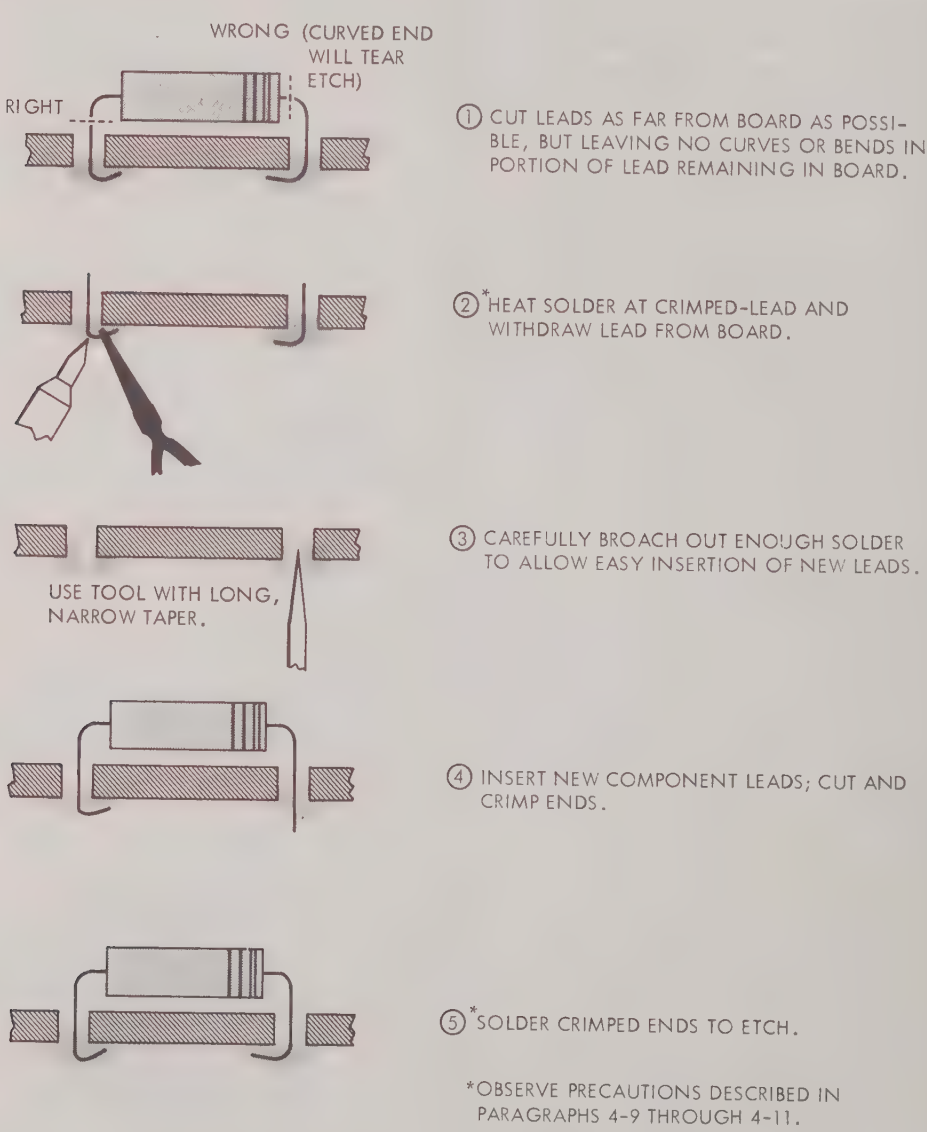

WRONG (CURVED END WILL TEAR ETCH)
RIGHT
① CUT LEADS AS FAR FROM BOARD AS POSSIBLE, BUT LEAVING NO CURVES OR BENDS IN PORTION OF LEAD REMAINING IN BOARD.
②* HEAT SOLDER AT CRIMPED-LEAD AND WITHDRAW LEAD FROM BOARD.
USE TOOL WITH LONG, NARROW TAPER.
③ CAREFULLY BROACH OUT ENOUGH SOLDER TO ALLOW EASY INSERTION OF NEW LEADS.
④ INSERT NEW COMPONENT LEADS; CUT AND CRIMP ENDS.
⑤* SOLDER CRIMPED ENDS TO ETCH.
*OBSERVE PRECAUTIONS DESCRIBED IN PARAGRAPHS 4-9 THROUGH 4-11.

Figure 4-2. Replacing Components on Etched Boards

est optimum temperature, and efficient heat sinks used wherever possible. It is advisable to use eutectic solder, which is relatively inexpensive insurance for the etched boards and any components (especially semiconductors) which may be damaged by an overly hot iron. It should be noted that leads of components are given a slight crimp before soldering. Before attempting to remove a component, clip leads close to the body of the component and throw it away; then carefully heat the leads and withdraw them from the etched side of the board. This will allow withdrawal of leads from the assembly with no damage to the lamination or to the signal paths of the etched board. Removal of large cans may be facilitated by lightly whisking off excess solder after applying heat to the prongs or tabs. Alternatively, special etched board de-soldering kits are commercially available.

4-12. If facilities or personnel do not permit safe replacement of any of the components on the etched board, it is recommended that a spare etched board assembly be stocked for each of the subassemblies in the amplifier, thus avoiding down time. In the event of replacement, the removed assembly may be returned to the factory for service. Upon return of the repaired assembly, it may be stocked as the replacement spare. ALWAYS OBSERVE THE PRECAUTIONS DESCRIBED IN PARAGRAPHS 4-9 THROUGH 4-11.

4-13. REPLACING ETCHED BOARDS. Main-board subassemblies are held in place by six screws -- three on either side. Before the screws are removed, the following steps (illustrated in Figure 4-3) should be taken:

a. Loosen the four screws which secure the amplifier-to-housing connector to the chassis.

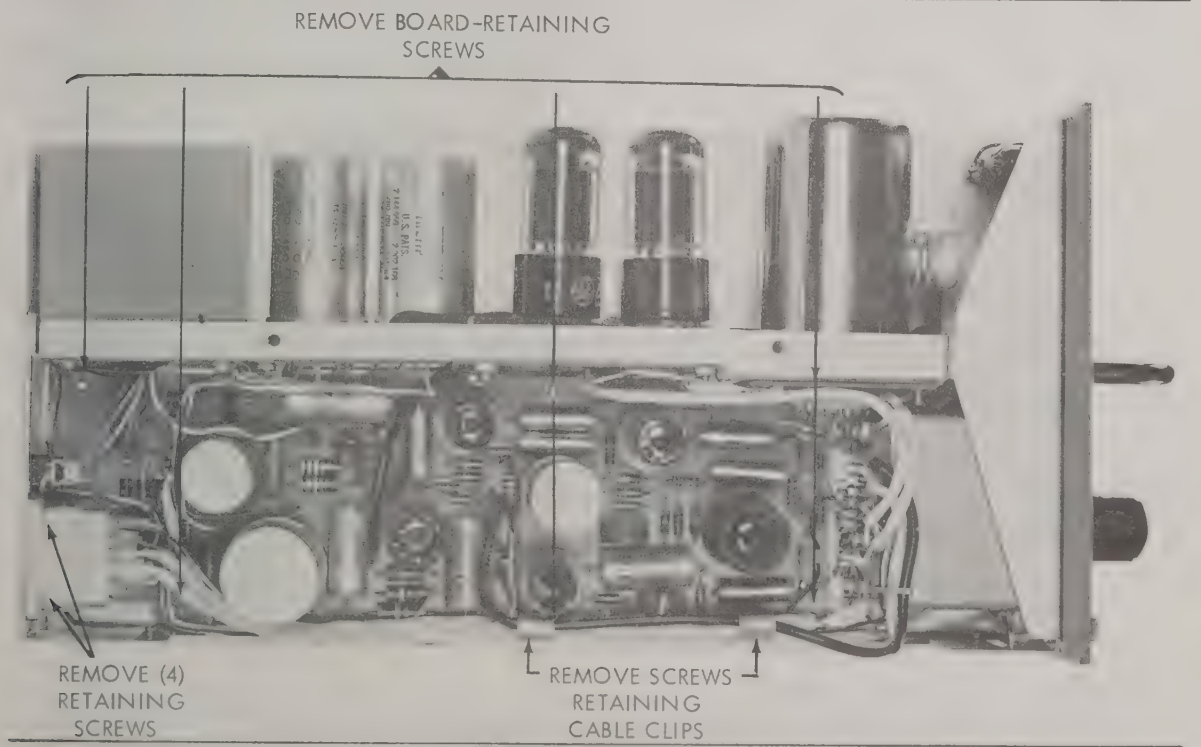


Figure 4-3. Replacing Main Etched Board Assembly

b. Remove the screws which secure the cable clips to the chassis.

c. Unsolder the cable leads from both boards; lay aside cable, clips, and connector.

d. Unsolder and remove transformer-leads from main-board pins.

e. Unsolder and remove the chopper-leads from main-board pins.

f. Unsolder and remove main-board wiring from pins on output board.

g. Unsolder and remove plug-in connector leads from main board.

h. Remove six screws holding board to chassis and carefully maneuver assembly out of chassis well.

4-14. Removal of the output amplifier subassembly is considerably less involved. Assuming that the main board has not been removed, the following steps (illustrated in Figure 4-4) should be taken to remove the output board:

a. Remove two 6BX7GT tubes (V201 and V202) from their sockets and lay them aside.

b. Unsolder and remove all leads from pins on the top side of the board; bend back cable-retaining tabs.

c. Unsolder and remove all leads from pins on the bottom of the board.

d. Remove the six board-retaining

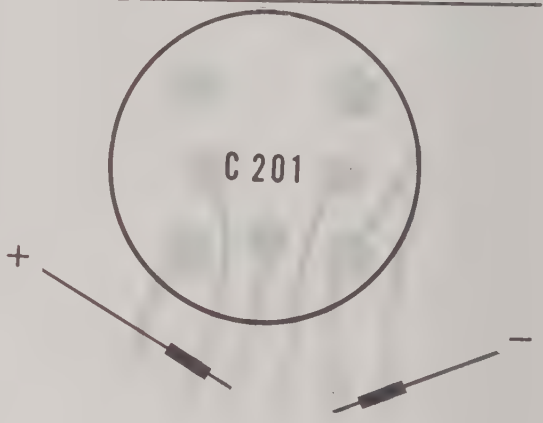


Figure 4-5. Testing Conductance of Diodes CR301, 302, 311, 312

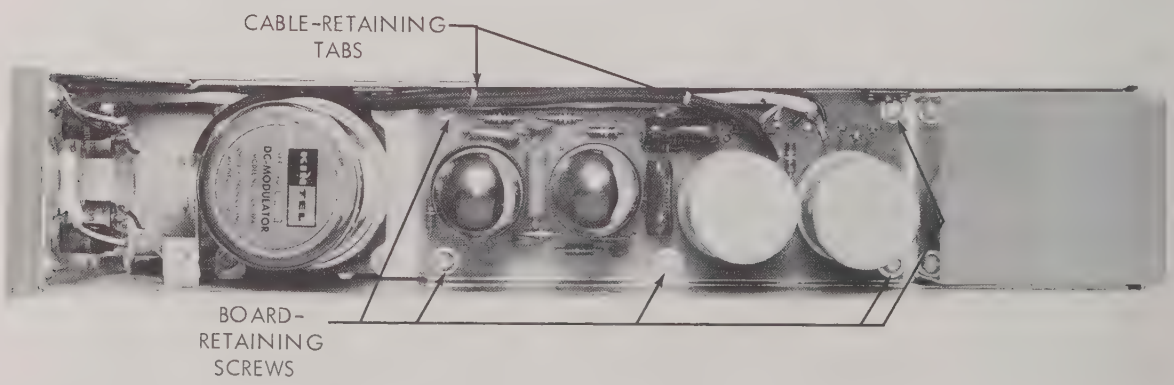


Figure 4-4. Replacing Output Amplifier Board Assembly

screws; lift board assembly from chassis.

4-15. To replace either assembly, follow reversal of outlined procedure. Again, extreme emphasis is placed on the precautions listed in paragraph 4-11.

4-16. VACUUM TUBES. Logically, vacuum tubes are prime suspects in any electronic instrument in which an anomaly appears. Therefore, one of the first steps in troubleshooting the Model 112A should be the checking of voltage measurements (refer to paragraph 4-72).

4-17. It must be implicitly understood that the best of tube-testing equipment cannot provide true evaluation of a tube's worth as can the actual observation of that tube's performance in the precision circuits of the Model 112A.

4-18. DIODES. Silicon diodes CR301, CR302, CR311, and CR312 may be checked in the circuit by measuring the +360 volts DC output across C201A (Figure 4-5). Silicon diodes CR303, CR304, CR313, and CR314 may be checked in the circuit by measuring the +200 volt DC output across C303 (Figure 4-6). CR305 and CR306 may be checked by measurement of the +12 volt DC output across C301 (Figure 4-7.)CR309 and CR310 may be checked by measuring the 13 volts DC as indicated in Figure 4-8. Selenium diodes CR307 and CR308 may be checked by substitution.

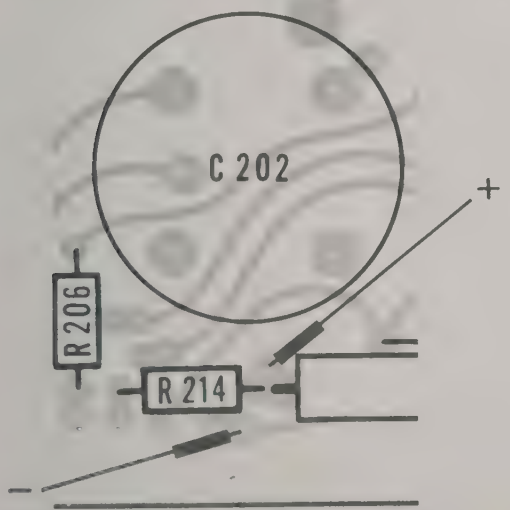


Figure 4-6. Testing Conductance of Diodes CR303, 304, 313, 314

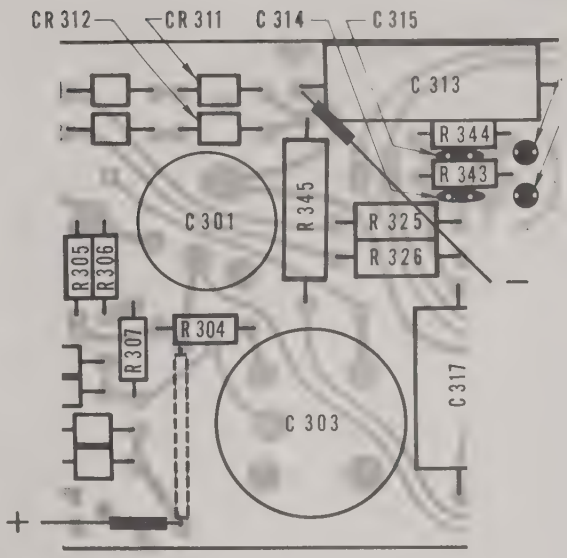


Figure 4-7. Testing Conductance of Diodes CR305 and CR306

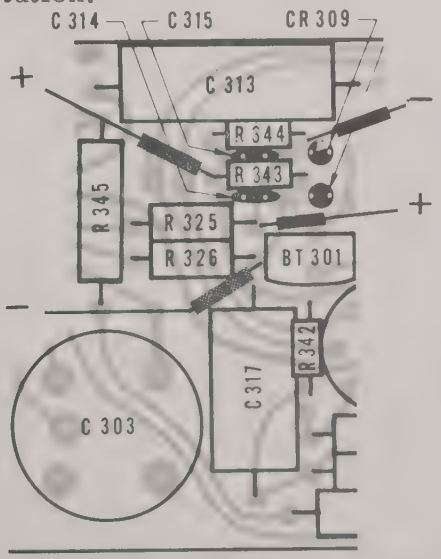


Figure 4-8. Testing Conductance of Diodes CR309 and CR310

4-19. When one of a pair of diodes is suspected or proved anomalous, it is good policy to replace both. Where one diode is found to be shorted, the other will have incurred damage; if one diode is open, the characteristics of the remaining one will probably differ from those of a newly replaced mate. The safest practice is the replacement of paired diodes by a new pair.

4-20. CHOPPER. The only continuously moving part in the Model 112A amplifier is the chopper. When not subjected to severe or continuous overloads, the chopper may operate for an indefinite period. The most common evidences of chopper trouble are drift and noise. The only valid test of a chopper's performance is to substitute a chopper known to be good.

4-21. It is often inadvisable to discard a chopper which has been replaced, especially if additional amplifiers or other chopper-modulated equipments are on hand. Occasionally, a chopper will function satisfactorily in one unit and not in another; many devices do not require the precision demanded of the chopper by KIN TEL amplifiers. One axiom only must be followed: The most conclusive check of any chopper is that performed when it is installed in the instrument in which it is used, and that instrument tested for proper operation according to the manufacturer's specifications.

4-22. For further information on the nature and operation of choppers, refer to KIN TEL Service Notes (Code No. 13-57): Chopper Checkout Procedure for KIN TEL Equipment.

4-23. BLOWER MOTORS. As mentioned in paragraph 4-7, improper lubricants can clog fan-motor bearings, resulting in one of several conditions requiring cleaning of the mechanism. If this becomes necessary, the motor should be removed from the housing and disassembled as shown in the exploded view in Figure 4-9.

4-24. After the motor is disassembled, the bearings may be cleaned by lightly scraping the surfaces of each bearing to remove any hardened deposits and then soaking the entire bearing assembly in a solvent for at least four hours. A stiff brush dipped in the solvent may aid in removing deposits from the rotor shaft.

4-25. When soaking has sufficiently removed deposits on the bearings, all surfaces should be wiped dry with a clean, lint-free cloth. Ascertain that there is no deposit remaining before beginning re-lubrication.

WARNING

Certain solvents emit insidiously toxic vapors. BE SURE VENTILATION IS ADEQUATE FOR THE SOLVENT BEING USED.

4-26. After bearings are clean and dry, place the assembly in an oil bath, using only the recommended lubricant (Shell Oil Co., Tellus No. 33). Soak in the oil bath for two hours, remove from bath, and wipe off excess oil. The motor may then be reassembled, again using the exploded view in Figure 4-9 as a guide.

4-27. Care should be used in aligning the motor shaft and bearings before the four frame bolts are tightened. Since the bearings are semi-floating, no difficulty should be encountered in assembling them properly.

*Later model housings (such as the Model 190A) employ fans which require no lubrication or disassembly.

4-28. Subsequent oiling should occur at regular intervals, length of which should be determined as stated in paragraph 4-7. Frequent removal of accumulated dust from the motor by means of compressed air is recommended; however, amplifiers should be unplugged and removed to an area safe from contamination before such blowing operations are performed.

4-29 PART LIFE EXPECTANCIES

4-30. VACUUM TUBES. The tubes used in the Model 112A Wideband DC Amplifier may reasonably be expected to operate satisfactorily for over 1000 hours (refer to Table 4-1). Satisfactory operation has been observed in many units having tubes two or three times the conservative ages shown in Table 4-1. There is no stated or implied recommendation that tubes -- or any other parts -- be changed at the end of the hours tabulated. Conversely, a 5751 amplifier tube (V301A/B) with 1000 hours of operation is preferable in the circuit to a new and untried 5751; acceptable tube transconductance is far more demonstrable by use in the circuit than by checking with any tube tester.

Table 4-1. Tube Life Expectancy

CIRCUIT SYMBOL	TUBE TYPE	EXPECTED LIFE
V201 and V202	6BX7GT	2000 hours
V301	5751	1500 hours
V302	6AU6	1500 hours
V303	6CB6	1000 hours
V304 and V305	6AU6	1500 hours

4-31. Tube failure at an age less than that shown in the table does not necessarily mean that associated circuit parts have changed value, but recurrent failure certainly warrants an extensive check of all circuit components.

4-32. Vacuum tubes employed in the Model 112A are more subject to gradual deterioration than to abrupt failure. As the emission of one or more tubes degrades over a period of time, the gain of the Model 112A undergoes a commensurate loss -- ultimately to the point where new tubes are necessary. Such gain loss may -- in very critical applications -- require readjustment of the Micro-Gain control (R415) as described in paragraph 2-46. To increase gain, the control should be rotated clockwise. Due to the small effect on overall gain of the amplifier (perhaps 2% in extreme cases) by loss of tube emission, it is not likely that

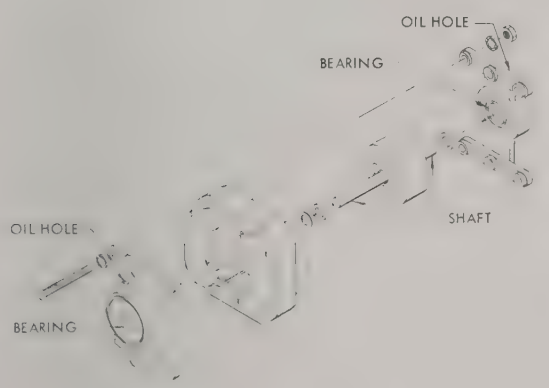


Figure 4-9. Exploded View of Fan Motor Assembly

such adjustment of the Micro-Gain control will be required in most installations.

4-33. DIODES. Although diodes used in the Model 112A are not likely to fail under normal operation, there exists the possibility of damage by excessive current as a result of circuit changes following the failure of other components. The same kind of damage might result from careless probing of the circuit. The remaining risks are overheating from soldering tools (refer to paragraph 4-11) and accidental breakage of the diode case. Tests outlined in paragraphs 4-18 will reveal any of these anomalies, and the rule given in paragraph 4-19 should be followed strictly to insure subsequent performance.

4-34. CHOPPERS. As was stated in paragraph 4-20, choppers may operate for an indefinite period under favorable conditions. A general life expectancy of 10,000 hours of operation is perhaps an acceptable average for mechanical choppers. Under advantageous conditions, satisfactory performance frequently has been obtained for periods as long as 25,000 operating hours. It is recommended that only KIN TEL Model DCM-88A be used as a chopper replacement. If the DC balance requires adjustment due to chopper replacement, refer to the DC balance-adjustment procedure given in paragraphs 2-47 and 2-48.

4-35. Due to the variation between choppers of different manufacture, it is recommended that technical personnel responsible for operation and maintenance of Model 112A amplifiers become familiar with the precision modulators which furnish the chopping action. Reference is made to KIN TEL Service Notes (Code No. 13-57) entitled Chopper Checkout Procedure for KIN TEL Equipment.

4-36. BIAS CELLS. Due to the negligible current drain on the mercury cells (BT301, BT302, and BT303) used for bias voltages in the Model 112A, operational life of the cells should be the same as their normal shelf life (approximately two years). Characteristically, these cells remain at full potential (1.35 volts) until just before complete failure. Any cell measuring 1.2 volts or less (as read by a vacuum tube voltmeter connected directly across the cell) should be immediately replaced.

4-37. MISCELLANEOUS PARTS. Application will largely determine the life expectancies for switches, resistors, capacitors, coils, or transformers. Depending on the values and individual characteristics of these components, and the applied voltages and current flowing through them, useful lives may range from long to very long. As a generalization, resistors are expected to last longer than coils and transformers, which in turn usually outlast capacitors. Small capacitors are customarily used longer than large electrolytic units. In the Model 112A, values and tolerances of all components have been selected conservatively (to provide full benefit offered by the safety margins allowed in the manufacturers' ratings). Consequently, the shortest lived of these parts may be expected to operate longer than vacuum tubes.

4-38 SERVICE PROCEDURES

4-39. The procedure recommended for locating any source of deviation in the Model 112A is that applied in most

electronic trouble shooting; i.e., the systematic measurement of DC plate voltages to reveal the anomalous stage, followed by critical examination of the circuitry in that stage to pinpoint the trouble source.

4-40. An oscilloscope is of inestimable value in trouble shooting precision amplifiers, especially if the technician is familiar with the correct waveforms which should appear at specific test points. To aid in such familiarization, normal waveform oscillograms are included in this manual (refer to paragraph 4-70).

4-41. As with any electronic equipment oscilloscopic analysis will reveal, and aid in localizing, any source of trouble, but it remains for the technician to pinpoint the actual component or connection at fault by means of voltage- and resistance-checks (and finally by means of substitution). A list of recommended service equipment is provided in the supplementary section of this manual.

4-42. OPENING THE LOOP. A very important characteristic of amplifiers employing great amounts of feedback is the reflection of signals from one stage to another via the feedback loop. Obviously, signal tracing can be considerably simplified if the loop were opened, allowing independent checks of each stage.

4-43. The loop should not be opened at random points; in certain cases this may affect components adversely, even to the point of requiring replacement. For open-loop servicing of the Model 112A, the following procedure is used:

a. Prepare a test socket adapter (such as G-C 9247, Peco TVS-7, Vector T-7-M, Walsco 1949-07, etc.) by cleanly cutting off Pin 1 of the adapter, assuring total isolation of that pin from connection No. 1 of any socket in which it is used. See Figure 4-10.

b. Assemble and connect to the adapter a network (as shown in Figure 4-10) employing a 1-megohm pot and the same kind of bias cells as are used in the Model 112A (BT301, BT302, and BT303). If desired, extra adjustment may be provided by connecting a small pot in series with the 1-meg unit.

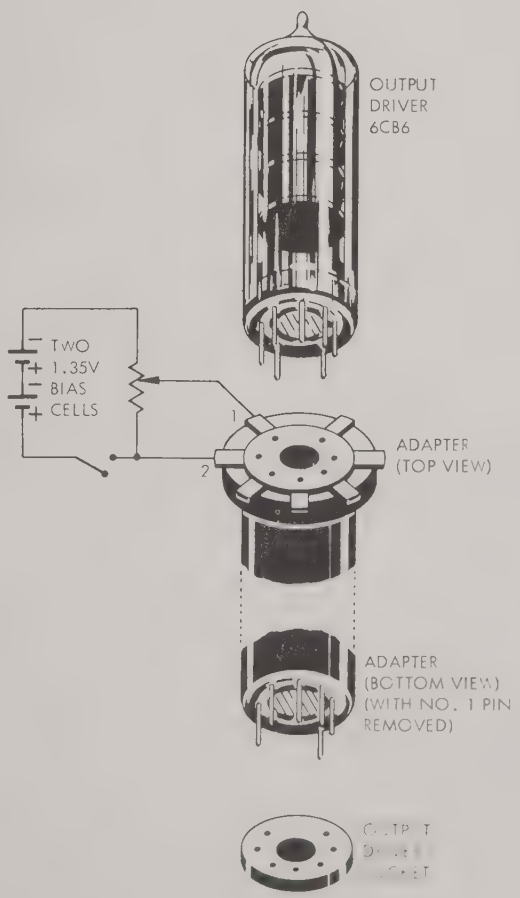


Figure 4-10. Open Loop Servicing

c. Remove V303 (6BC6) from its socket, install adapter in the socket, and plug V303 into the adapter.

d. Adjust the control(s) of this external circuit to bias the stage for approximate zero output from the amplifier.

4-44. With the overall loop broken in this manner, each amplifier stage may be individually examined; the only remaining interaction between stages is that existing through the sharing of a common power supply and the overload recovery circuit to SJ1. Thus standard servicing procedures may now be used -- measuring stage gains and grounding or opening circuits throughout the amplifier without introducing instability or reflecting anomalous signals to other stages. Note that chopper-amplifier servicing may be facilitated by adjusting this external bias to introduce a slight offset.

4-45. CHOPPER REPLACEMENT. Choppers are installed in standard 6-pin porcelain sockets. However, to isolate the drive coil from the chopper contacts, drive voltage is applied through a 2-pin connector on the side of the chopper case. The mating connector on the drive-voltage line is removed by grasping it and pulling straight out from the chopper case.

4-46. After the drive connector is removed, the chopper retaining clamp must be detached from the chassis before the chopper may be taken from its socket. As shown in Figure 4-11, the clamp is secured to the chassis side panel by a single screw. Remove the screw and associated washers carefully, and set aside. The chopper may now be removed (with the clamp still attached) by the application of a slight rocking motion while pulling upward from the socket. When reinstalling the chopper, be sure to maintain the order of assembly for washers as shown in the exploded view in Figure 4-11.

4-47. TUBE REPLACEMENT. The tubes in the Model 112A are removed in a straightforward manner. Be sure that shields are properly installed on the correct tubes in the main circuit board assembly.

4-48 TESTS AND TROUBLESHOOTING

4-49. Tests for checking performance of the Model 112A Wideband DC Amplifier will largely depend upon the type of function plug-in being used. Therefore, the proper procedures and supporting data for amplifier tests are included in the manual supplement for each specific plug-in.

4-50. TROUBLESHOOTING. A very basic step in troubleshooting a Model 112A which is inoperative or malfunctioning is the checking of leakage resistance between signal ground and chassis. This resistance should be at least 50 megohms and is typically several hundred megohms as measured by a megohmmeter.

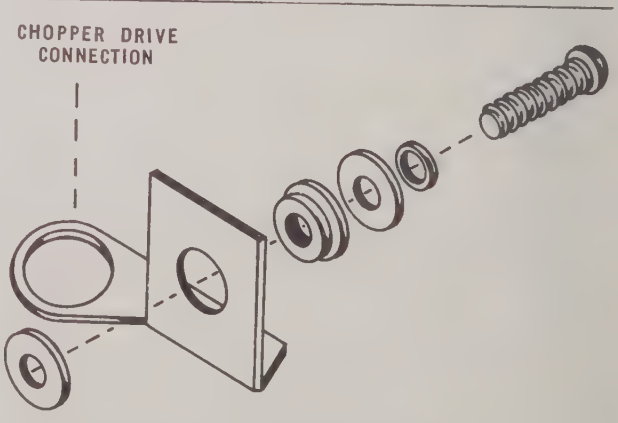


Figure 4-11. Chopper Clamp Assembly (Exploded View)

4-51. Bias cell voltages should be checked as described in paragraph 4-36. Only after leakage to ground and bias cell voltages prove to be normal should the amplifier power be turned on to permit further troubleshooting.

4-52. The Model 111TC Test Cable (described in paragraph 2-10 and illustrated in Figure 2-1) will be useful in troubleshooting, since it permits the amplifier to be operated outside its housing. However, the signal-to-noise ratio will be increased by the introduction of stray fields in the work area, since the amplifier housing normally serves as additional shielding for the instrument.

4-53. Generally, if leakage to ground and bias voltages are correct, the simplest expedient to troubleshooting is the open-loop procedure described in paragraphs 4-42 through 4-44. With the loop opened, trouble sources may be localized.

4-54. GAIN CHECKS. A properly terminated attenuator (such as the Hewlett-Packard Model 350A) will permit controlled gain checking. With the attenuator set at zero, apply a 1-volt DC signal and note its amplitude on the oscilloscope. Move the scope connection to SJ3 and the attenuator to the Model 112A input, adjusting the attenuation to provide the same signal amplitude as first noted. Attenuator setting will reveal carrier amplifier gain. Similar application of an AC signal reveals wideband amplifier gain. By moving the attenuator to SJ3 and taking final measurement at the output, the output amplifier gain may be determined. If any amplifier gain is abnormal, individual stages may be checked to pinpoint the trouble source. Table 4-2 lists nominal gains of all stages and amplifiers.

4-55. Certain phases of troubleshooting will depend -- as with performance tests -- upon the specific function plug-in used. These are dealt with in the manual supplement for the respective plug-in. Other areas are more general in nature, and may be considered as pertinent to the Model 112A without regard to attenuation or feedback.

4-56. NOISE. Noise originates in tubes or other faulty components or connections, or is generated by the improper dressing of leads or cables. Noise spikes such as those illustrated in Figure 4-12 may result from faulty chopper operation. For details, refer to Chopper Checkout Procedure for KIN TEL Equipment (Code 13-57).

4-57. 30-cps noise may result from an unbalance between the hf amplifier and the chopper amplifier. Further investigation may reveal the cause of imbalance to be a weak bias cell (BT302), a defective screen-bypass capacitor (C201C or C317), or a defective tube in either the hf amplifier or chopper amplifier.

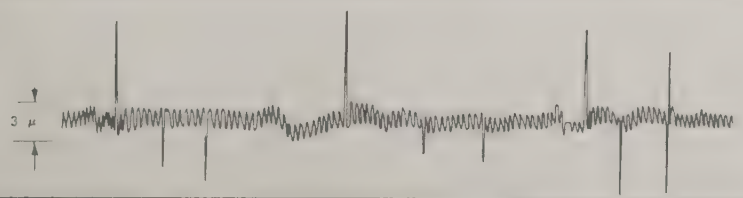


Figure 4-12. Noise Spikes Caused by Defective Chopper

4-58. 60-cps noise (perhaps the more common intrusive factor in most installations) may originate in system ground loops rather than the circuits within the amplifier. Other sources of 60-cps noise are poor filters, open screen-bypass capacitors, and tubes with excessive heater-grid leakage.

4-59. Random noise at low frequencies may usually be traced to V301 or -- less frequently -- V304 or V305. Microphonics or random noise at the higher frequencies -- especially if relatively unaffected by changes in gain -- are most likely to originate in V301.

4-60. Persistent noise which cannot readily be localized is often indicative of improperly soldered connections, or inadequate shielding and/or grounding. Lead dress problems have been minimized in the Model 112A by judicious use of cable ties and clamps, as well as the confinement of component mounting to etched boards. One basic rule to remember is that all disc capacitors and diodes should be straightened at all times so that they are perpendicular to the board on which they are mounted, to insure maximum isolation.

4-61. OSCILLATION. High-frequency oscillation will usually be pinpointed near the output stage or in the function plug-in. An open capacitor, such as C204, would result in hf oscillation.

4-62. Oscillation at a very low frequency -- such as 1 cps -- with sufficient amplitude to overload the amplifier indicates that V304 or V305 is faulty or improperly coupled. An open chopper -- although this is an extreme rarity -- could present an oscillation which would have a decidedly semi-cyclic characteristic.

4-63. OVERLOAD. A change in the gain differential between the hf amplifier and the chopper amplifier will produce an amount of hum proportional to the degree of gain change; if this amount is large enough, the amplifier will be overloaded. Such changes in gain can be caused by a drop in B+ voltage, an open input capacitor, vacuum tube failure, or any of several other malfunctions.

4-64. OVERLOAD RECOVERY. If the amplifier is slow to recover from overload while operating within all other specifications, check the circuit between V304 plate and V302 grid, and BT303 and associated circuit components.

4-65. DEMODULATOR CHECK. If diodes CR309 and CR310 are believed to be faulty, connect an oscilloscope to the negative junction (the junction of R326 and CR310) and observe the waveform. Then short the plate of V305 to ground and observe to see if the diode waveform changes. If the shorting of V305 plate changes the waveform, the demodulator is at fault. If the same waveform is obtained whether V305 plate is shorted or not, the trouble lies elsewhere. When replacing these diodes, follow the policy outlined in paragraph 4-19.

4-66 PART IDENTIFICATION

4-67. Figures 4-2 through 4-8 and 4-13 through 4-18 will aid in the location and identification of component parts of the Model 112A Wideband DC Amplifier. Illustrations in other sections of this manual will also provide location information. For detailed identification of components in the function plug-in, refer to the supplementary section. Use of the schematic diagram (refer

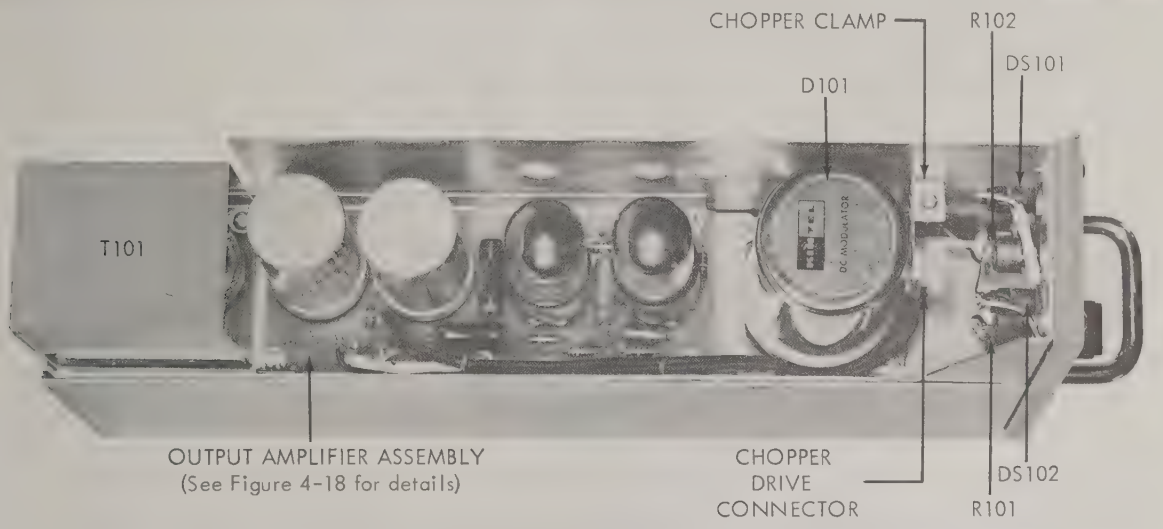


Figure 4-13. Model 112A Final Assembly (Top View)

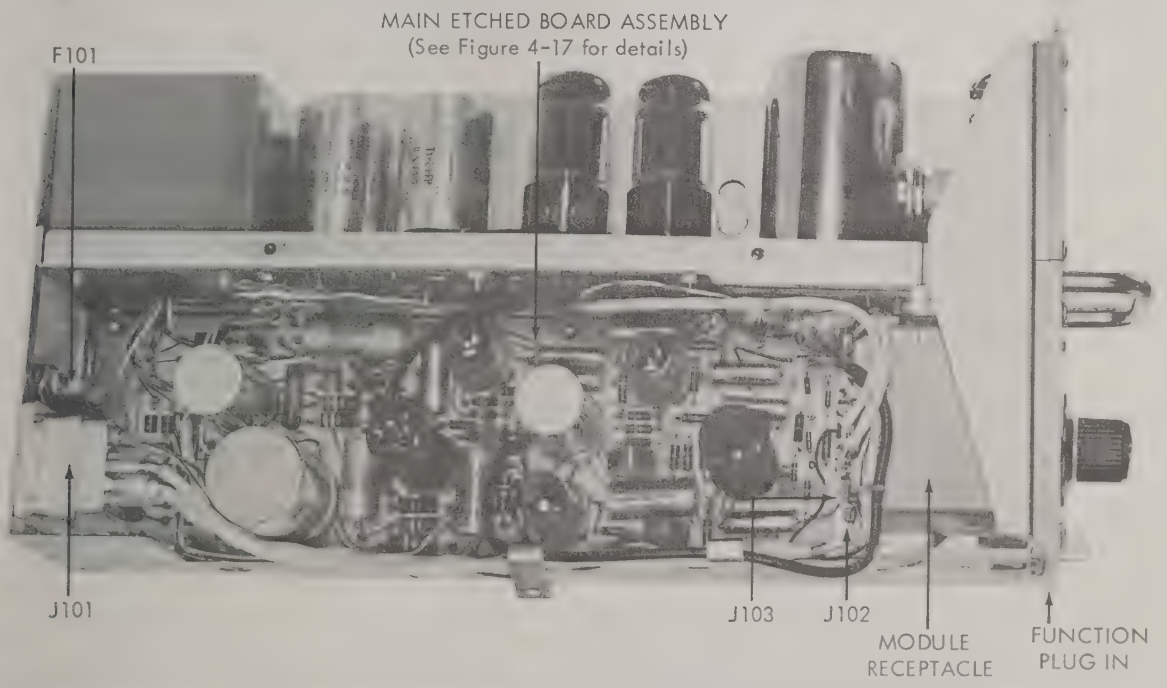


Figure 4-14. Model 112A Assembly with Guard Panels Removed

to paragraph 4-74) in conjunction with these illustrations will expedite the procedure, particularly when following the etched circuit patterns in Figures 4-17 and 4-18.

4-68 MAINTENANCE SUPPORT DATA

4-69. Maintenance procedures for the Model 112A are supported by the inclusion of data such as waveform oscillograms, pertinent voltages, list of replaceable parts, and schematic diagrams. Note that -- just as the Model 112A is not complete without a function plug-in -- maintenance data for the amplifier is incomplete without proper coverage for the function plug-in used. The supplementary section of this manual contains data required for proper operation and maintenance of the respective plug-in, as used in the Model 112A.

4-70. WAVEFORMS. Figures 4-19 through 4-31 illustrate typical waveforms observable at pertinent points in the amplifier. Possible deviation from a waveform -- with regard to size -- may stem from the use of an oscilloscope of different design, but waveforms will appear substantially as shown if no malfunction exists in the unit being tested. Signal amplitudes are implicitly shown by means of the noted oscilloscope sensitivities. Each square on the dial scale represents one centimeter.

4-71. Maintenance personnel are cautioned to observe a very important characteristic of amplifiers which feature a high percentage of feedback: Signal tracing can become a confusing procedure if the discrepant signal is mirrored throughout several stages by the feedback loop. Opening the loop will allow rapid tracing of the erroneous waveform to the offending stage. This procedure is outlined in paragraphs 4-42 through 4-44.

4-72. MEASUREMENT TABLES. Table 4-3 lists nominal voltages as measured to common from pertinent points in the Model 112A with the Model 112A-A Plug-In installed. Table 4-4 indicates the nominal resistances to common as measured from the same points under static conditions.

4-73. PARTS LIST. Table 4-5 lists the replaceable parts of the Model 112A Wideband DC Amplifier. Those parts which are recommended for stocking as spares are marked by an asterisk. The manufacturers are designated by code, and these tabulations may be decoded by reference to the list of Manufacturers' Code Designations (Table 4-6). Components of the function plug-in are tabulated in the supplement for the respective plug-in.

4-74. SCHEMATIC DIAGRAM. Figure 4-32 schematically illustrates the circuitry of the Model 112A, with the exception of the attenuator. The schematic diagram of the function plug-in used will be found in the manual supplement dealing with that particular plug-in. Note that J102 and J103 in Figure 4-32 mate with P102 and P103 in the schematic diagram of the associated function plug-in.

Table 4-2. Stage and Section Gains: Model 112A Wideband DC Amplifier

SECTION	APPLIED SIGNAL FREQUENCY	STAGE	STAGE GAIN (db)	SECTION GAIN (db)
WIDEBAND		V301A	33	
	1 kcps	V302	46	128 (AC)
AMPLIFIER		V303	49	
DC AND LOW		V301B	33	115 (AC)
FREQUENCY	60 cps	V304	36	
AMPLIFIER		V305	46	105 (DC)
OUTPUT AMPLIFIER	DC	V201/V202	UNITY	UNITY

(Note that -- due to interstage effects and associated networks -- overall gains will not necessarily equal the sum of the gains of the individual stages.)

Table 4-3. Voltage Measurements: Model 112A Wideband DC Amplifier

TUBE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	TUBE
V201	-9.5	150	0	-9.5	150	0	FIL	FIL	NP	6BX7GT
V202	-115	0	-105	-115	0	-105	FIL	FIL	NP	6BX7GT
		V301B					V301A			
V301	125	-1.35	0	FIL	FIL	125	-1.35*	0	0	5751
V302	-1.35*	0	FIL	FIL	220	70	0	NP	NP	6AU6
V303	-1.5	0	FIL	FIL	140	75	0	NP	NP	6CB6
V304	-1.35*	0	FIL	FIL	155	40	0	NP	NP	6AU6
V305	-1.35*	0	FIL	FIL	120	60	0	NP	NP	6AU6

Conditions: Input shorted; output terminated in 1000 ohms; voltages measured from indicated pins to circuit common, with common grounded to chassis.
NP: Indicates tube has no pin with specified number
*: Indicates presence of bias cell in measured circuit.

Table 4-4. Resistance Measurements: Model 112A Wideband DC Amplifier

TUBE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	TUBE
V201	600K	100K	10K	150K	100K	0.4	0.15	0.15	NP	6BX7GT
V202	200K	0.4	100K	200K	10K	100K	0.15	0.15	NP	6BX7GT
		V301B					V301A			
V301	220K	10M	0	3.5	3.5	220K	*INF	0	0	5751
V302	*1.8M	0	3	4.5	90K	25K	0	NP	NP	6AU6
V303	10M	0	0.15	0.15	82K	33K	0	NP	NP	6CB6
V304	*4M	0	0.15	0.15	270K	130K	0	NP	NP	6AU6
V305	*6M	0	0.15	0.15	270K	130K	0	NP	NP	6AU6

Conditions: Input and output open; resistances measured from indicated pins to circuit common, with common grounded to chassis; tabulation is in ohms.
NP: Indicates tube has no pin with specified number.
Indicates presence of bias cell in measured circuit; reading may vary if cell potential is not within specifications.

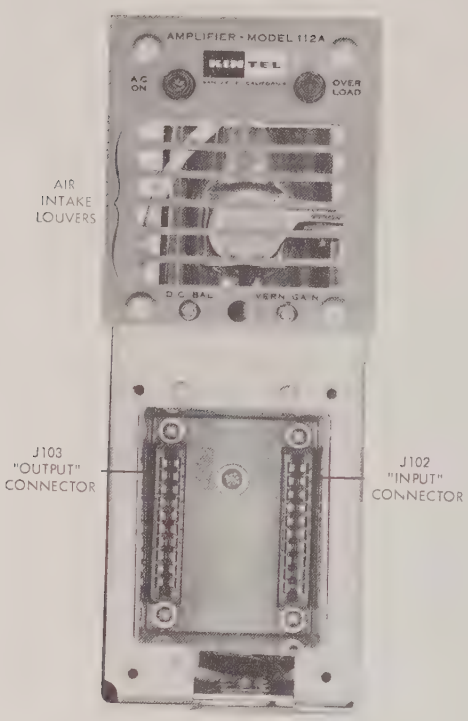


Figure 4-15. Model 112A with Function Plug-In Removed to Show Module Connectors

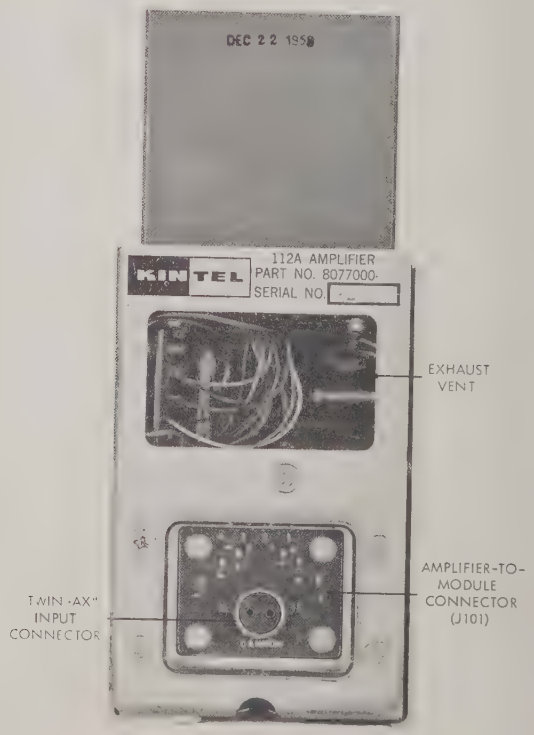


Figure 4-16. Rear of Model 112A, Showing Exhaust Air Vent

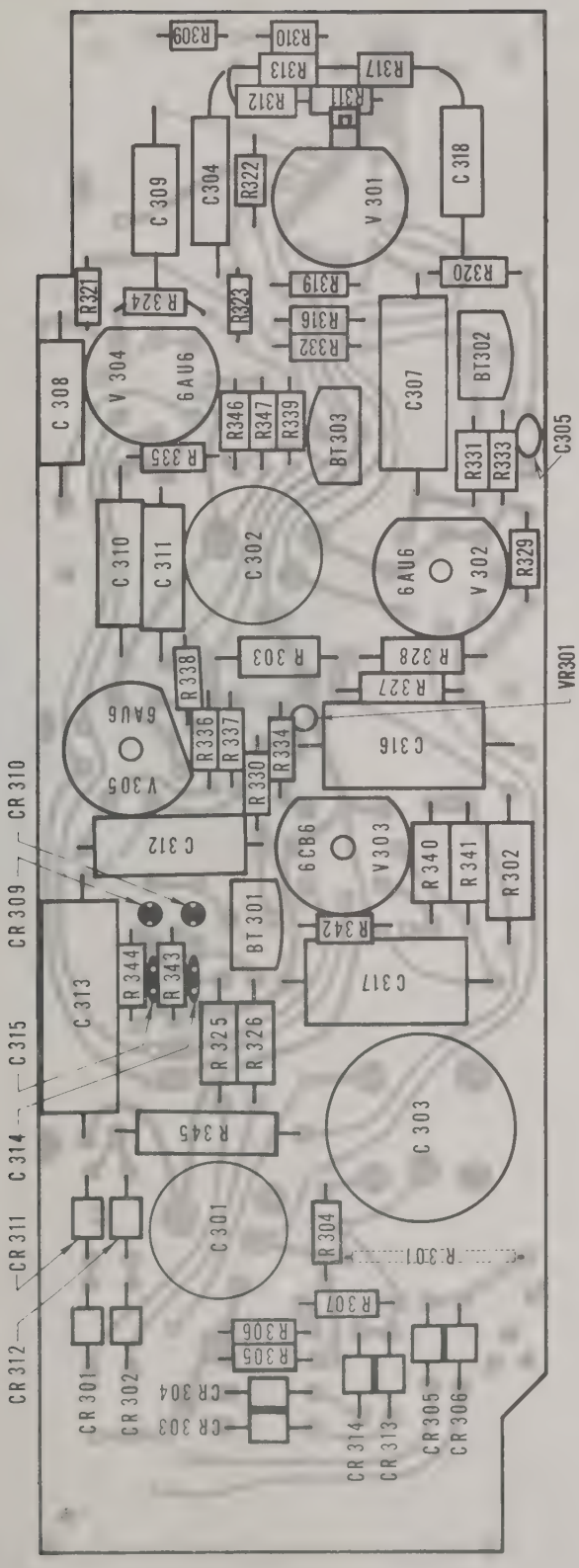


Figure 4-17. Main Etched Board Assembly, Showing Components

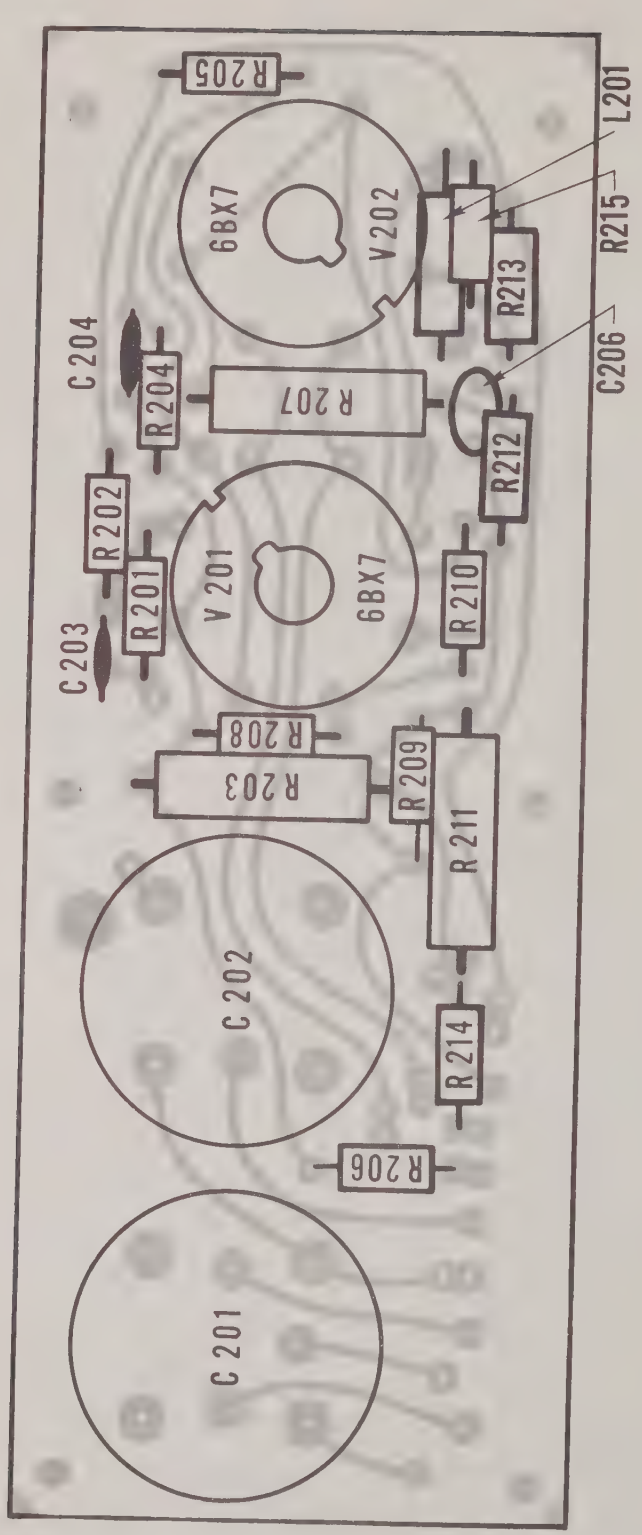


Figure 4-18. Output Board Assembly, Showing Components

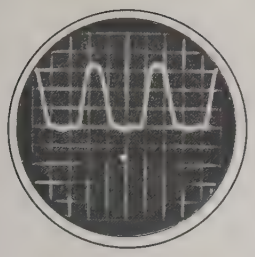


FIGURE 4-19.

POSITIVE DEMODULATOR WAVEFORM
(JUNCTION OF CR309 AND R325)
SENSITIVITY: 10V/C; SWEEP: 5 MS

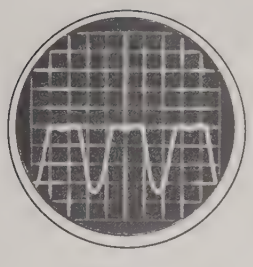


FIGURE 4-20.

NEGATIVE DEMODULATOR WAVEFORM
(JUNCTION OF CR310 AND R326)
SENSITIVITY: 10V/C; SWEEP: 5 MS

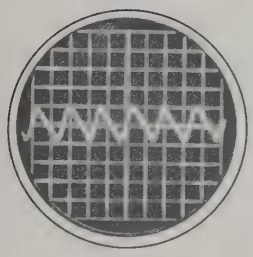


FIGURE 4-21.

NORMAL RIPPLE IN -150 VOLT REFERENCE
(JUNCTION OF R304 AND C303)
SENSITIVITY: 1V/C; SWEEP: 5 MS

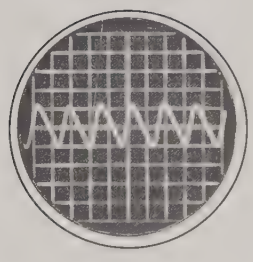


FIGURE 4-22.

NORMAL RIPPLE IN +200 VOLT REFERENCE
(JUNCTION OF R307 AND CR313-314)
SENSITIVITY: 1V/C; SWEEP: 5 MS

FIGURE 4-23.

NORMAL RIPPLE AT JUNCTION OF R345 AND C201A
SENSITIVITY: 0.5V/C; SWEEP: 5 MS

FIGURE 4-24.

NORMAL RIPPLE AT SJ4
SENSITIVITY: 0.5V/C; SWEEP: 5 MS

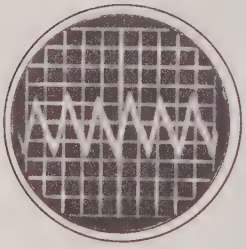


FIGURE 4-25.

NORMAL RIPPLE AT SJ3
SENSITIVITY: 1MV/C; SWEEP: 5 MS

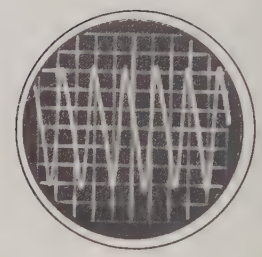


FIGURE 4-26.

NORMAL HEATER RIPPLE AT PIN 4 OF V302
SENSITIVITY: 0.2V/C; SWEEP: 5 MS

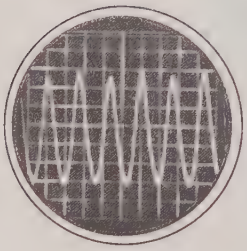


FIGURE 4-27.

NORMAL WAVEFORM AT V302 PIN 3 (V301 PINS 4 & 5)
SENSITIVITY: 10MV/C; SWEEP: 5 MS

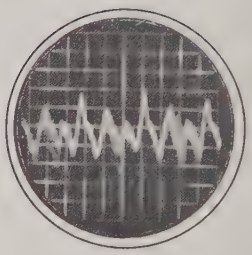


FIGURE 4-28.

NORMAL WAVEFORM AT PLATE OF V305
SENSITIVITY: 0.5V/C; SWEEP: 5 MS

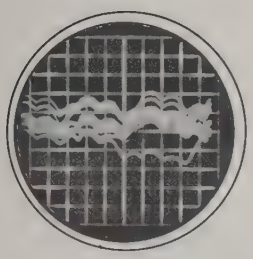


FIGURE 4-29.

NORMAL WAVEFORM AT PLATE OF V302
SENSITIVITY: 10MV/C; SWEEP: 5 MS

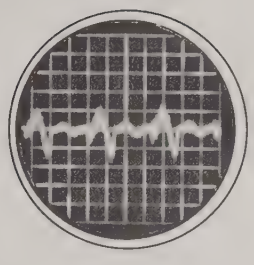


FIGURE 4-30

NORMAL WAVEFORM AT PLATE (PIN 5) OF V304,
SHOWING EFFECT OF CHOPPER ACTION
SENSITIVITY: 20MV/C; SWEEP: 5 MS

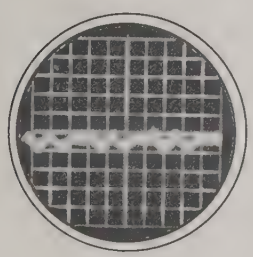


FIGURE 4-31

NORMAL WAVEFORM AT PLATE OF V301B
SENSITIVITY: 2MV/C; SWEEP: 5 MS

Table 4-5. List of Replaceable Parts

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
BT301	Cell, mercury, 1.35V, Type RM625T	MAL	1810003-001
BT302	Cell, mercury, 1.35V, Type RM625T	MAL	1810003-001
BT303	Cell, mercury, 1.35V, Type RM625T	MAL	1810003-001
C201	Electrolytic PC can, 30/40/8 µf, 450/450/150V	MAL	0510061-012
C202	Electrolytic PC can, 80 µf, 450V	MAL	0510061-013
C203	Ceramic Disc, 100 µµf, 600V	EIA	0401022
C204	Ceramic Disc, .01 µf, 600V	EIA	0401056
C206	Ceramic Disc, .01 µf, 600V	EIA	0401056
C301	Electrolytic PC can, 1000 µf, 15V	MAL	0510061-022
C302	Electrolytic PC can, 1000 µf, 15V	MAL	0510061-022
C303	Electrolytic PC can, 50 µf, 450V	MAL	0510121-001
C304	Polystyrene, .01 µf, 400V	SFE	0610067-103
C305	Ceramic Disc, 100 µµf, 600V	EIA	0401048
C307	Polystyrene, .05 µf, 400V	SFE	0610067-503
C308	Polystyrene, .01 µf, 400V	SFE	0610067-103
C309	Polystyrene, .01 µf, 400V	SFE	0610067-103
C310	Polystyrene, .01 µf, 400V	SFE	0610067-103
C311	Polystyrene, .01 µf, 400V	SFE	0610067-103
C312	Polystyrene, .022 µf, 400V	SFE	0610067-223
C313	Polystyrene, .1 µf, 400V	SFE	0610067-104

#Refer to Table 4-6

Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
C314	Ceramic Disc, .01 µf, 600V	EIA	0401056
C315	Ceramic Disc, .01 µf, 600V	EIA	0401056
C316	Polystyrene, .05 µf, 400V	SFE	0610067-503
C317	Mylar, .47 µf, 200V	SFE	0610066-474
C318	Polystyrene, .01 µf, 400V	SFE	0610067-103
CR301	Diode, silicon, Type 1N2071	TEX	3510030-001
CR302	Diode, silicon, Type 1N2071	TEX	3510030-001
CR303	Diode, silicon, Type 1N2071	TEX	3510030-001
CR304	Diode, silicon, Type 1N2071	TEX	3510030-001
CR305	Diode, silicon, Type 1N2069	TEX	3510030-002
CR306	Diode, silicon, Type 1N2069	TEX	3510030-002
CR309	Diode, selenium, Type 3U1	REC	3506774-007
CR310	Diode, selenium, Type 3U1	REC	3506774-007
CR311	Diode, silicon, Type 1N2071	TEX	3510030-001
CR312	Diode, silicon, Type 1N2071	TEX	3510030-001
CR313	Diode, silicon, Type 1N2071	TEX	3510030-001
CR314	Diode, silicon, Type 1N2071	TEX	3510030-001
D101	Converter, 60-cycle, DCM-88A	KT	6310010-001
DS101	Lamp, indicator, neon, miniature	ELD	1710036-001
DS102	Lamp, indicator, neon, miniature	ELD	1710036-001
F101	Fuse, Slo-Blo, 1 Amp, 125V	LTF	1710040-019
J101	Connector, amplifier-to-housing	CAN	1310064

#Refer to Table 4-6

Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
J102	Connector, printed circuit	CNH	1310096-110
J103	Connector, printed circuit	CNH	1310096-110
L201	Coil, choke, 5 μh, ±20% (0-50 ma DC) 0.1 ohm maximum	EWC	6710011-002
R101	Potentiometer, 10K ohms, 1/2W	AB	5010181-003
R201	Composition, 1M ohms, 1/2W, 5%	AB	0310030-105
R202	Composition, 1M ohms, 1/2W, 5%	AB	0310030-105
R203	Wire-wound, 2250 ohms, 5W, 10%	OHM	5110010-041
R204	Composition, 680K ohms, 1/2W, 5%	AB	0310030-684
R205	Composition, 120K ohms, 1/2W, 5%	AB	0310030-124
R206	Composition, 100K ohms, 1/2W, 5%	AB	0310030-104
R207	Wire-wound, 1K ohms, 5W, 10%	OHM	5110010-034
R208	Composition, 120K ohms, 1/2W, 5%	AB	0310030-124
R209	Composition, 100K ohms, 1/2W, 5%	AB	0310030-104
R210	Composition, 75K ohms, 1/2W, 5%	AB	0310030-753
R211	Wire-wound, 2250 ohms, 5W, 10%	OHM	5110010-041
R212	Composition, 680K ohms, 1/2W, 5%	AB	0310030-684
R213	Composition, 120K ohms, 1/2W, 5%	AB	0310030-124

#Refer to Table 4-6

Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
R214	Composition, 270K ohms, 1/2W, 5%	AB	0310030-274
R302	Composition, 10K ohms, 2W, 5%	AB	0310032-103
R303	Composition, 39K ohms, 1W, 5%	AB	0310031-393
R304	Composition, 180K ohms, 1/2W, 5%	AB	0310030-184
R305	Composition, 470 ohms, 1/2W, 5%	AB	0310030-471
R306	Composition, 470 ohms, 1/2W, 5%	AB	0310030-471
R307	Composition, 220K ohms, 1/2W, 5%	AB	0310030-224
R309	Composition, 4.7M ohms, 1/4W, 5%	AB	4045000-475
R310	Composition, 5.6M ohms, 1/4W, 5%	AB	4045000-565
R311	Composition, 10K ohms, 1/4W, 5%	AB	4045000-103
R312	Composition, 6.8M ohms, 1/4W, 5%	AB	4045000-685
R313	Composition, 1K ohms, 1/4W, 5%	AB	4045000-102
R316	Composition, 10M ohms, 1/2W, 5%	AB	0310030-106
R317	Composition, 680K ohms, 1/4W, 5%	AB	4045000-684
R318	Composition, 1K ohms, 1/4W, 5%	AB	4045000-102
R319	Composition, 220K ohms, 1/2W, 5%	AB	0310030-224

#Refer to Table 4-6

Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
R320	Composition, 22K ohms, 1/2W, 5%	AB	0310030-223
R321	Composition, 1M ohms, 1/4W, 5%	AB	4045000-105
R322	Composition, 220K ohms, 1/2W, 5%	AB	0310030-224
R323	Composition, 10M ohms, 1/4W, 5%	AB	4045000-106
R324	Composition, 3.3M ohms, 1/2W, 5%	AB	0310030-335
R325	Composition, 330K ohms, 1W, 5%	AB	0310031-334
R326	Composition, 330K ohms, 1W, 5%	AB	0310031-334
R327	Composition, 82K ohms, 1W, 5%	AB	0310031-823
R328	Composition, 120K ohms, 1W, 5%	AB	0310031-124
R329	Composition, 47K ohms, 1/2W, 5%	AB	0310030-473
R330	Composition, 6.8M ohms, 1/2W, 5%	AB	0310030-685
R331	Composition, 1M ohms, 1/2W, 5%	AB	0310030-105
R332	Composition, 4.7M ohms, 1/2W, 5%	AB	0310030-475
R333	Composition, 680K ohms, 1/2W, 5%	AB	0310030-684
R334	Composition, 82 ohms, 1/2W, 5%	AB	0310030-820
R335	Composition, 180K ohms, 1/2W, 5%	AB	0310030-184
R336	Composition, 220K ohms, 1/2W 5%	AB	0310030-224
R337	Composition, 820K ohms, 1/2W, 5%	AB	0310030-824

#Refer to Table 4-6

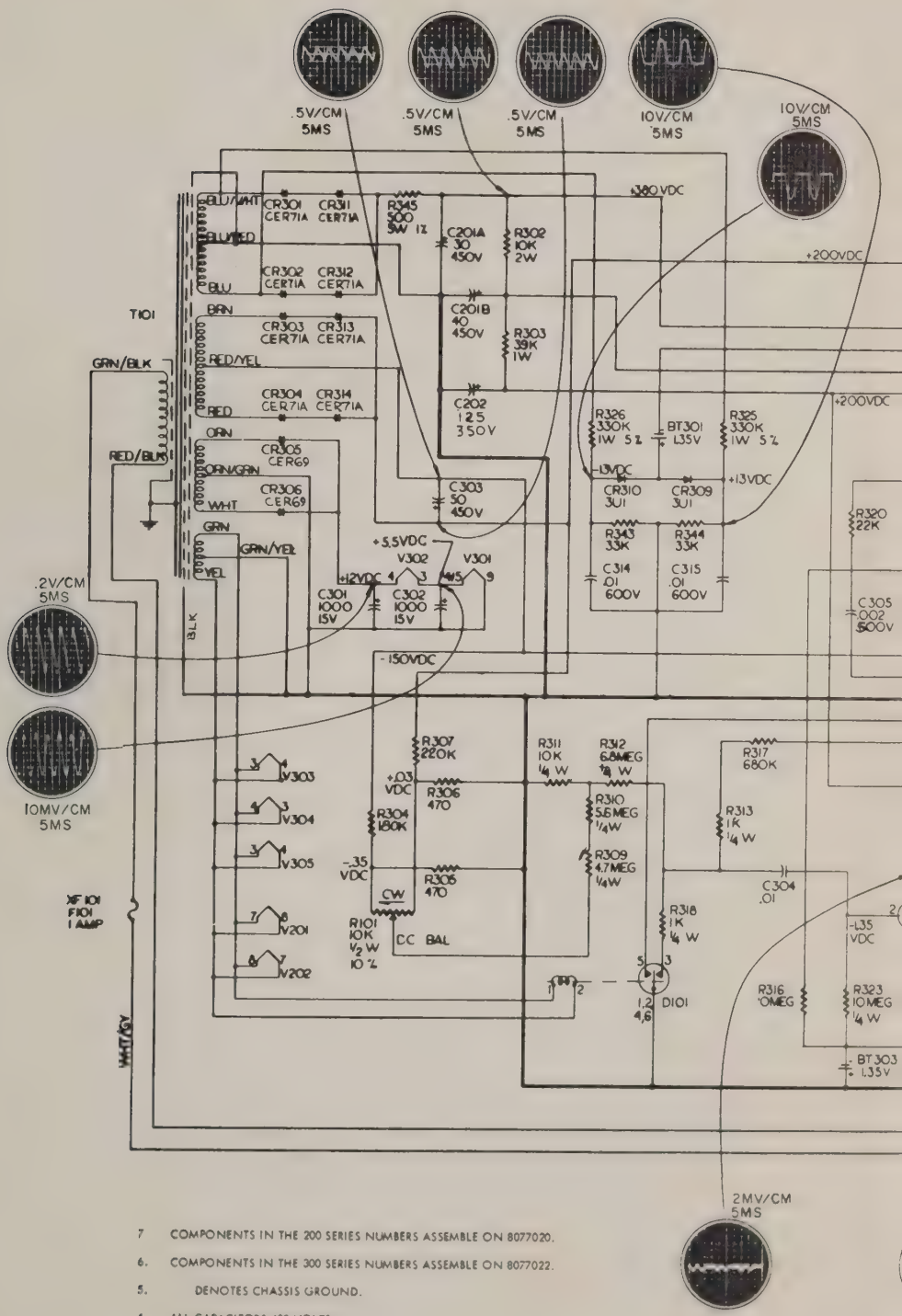
Table 4-5. List of Replaceable Parts (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
R338	Composition, 2.7M ohms, 1/2W, 5%	AB	0310030-275
R339	Composition, 3.3M ohms, 1/2W, 5%	AB	0310030-335
R340	Composition, 82K ohms, 1W, 5%	AB	0310031-823
R341	Composition, 120K ohms, 1W, 5%	AB	0310031-124
R342	Composition, 47K ohms, 1/2W, 5%	AB	0310030-473
R343	Composition, 33K ohms, 1/2W, 5%	AB	0310030-333
R344	Composition, 33K ohms, 1/2W, 5%	AB	0310030-333
R345	Wire-wound, 500 ohms, 5W, 1%	MEP	5210067-002
R346	Composition, 470K ohms, 1/2W, 5%	AB	0310030-474
R347	Composition, 150K ohms, 1/2W, 5%	AB	0310030-154
T101	Transformer, power	KT	6510065-001
V201	Tube, Vacuum Type 6BX7GT	EIA	7002768
V202	Tube, Vacuum Type 6BX7GT	EIA	7002768
V301	Tube, Vacuum, Type 5751	EIA	7302812
V302	Tube, Vacuum, Type 6AU6	EIA	7002748
V303	Tube, Vacuum, Type 6CB6	EIA	7002773
V304	Tube, Vacuum,Type 6AU6	EIA	7002748
V305	Tube, Vacuum,Type 6AU6	EIA	7002748
VR301	Tube, neon, Type NE2	GCM	1704151

#Refer to Table 4-6

Table 4-6. Manufacturers' Code Designations

CODE	MANUFACTURER	ADDRESS
AB	Allen-Bradley Co.	Milwaukee 4, Wis.
CAN	Cannon Electric Co.	Los Angeles, Calif.
CNH	Cinch Mfg. Co.	Chicago 24, Ill.
EIA	Any brand meeting EIA standards	
ELD	Eldema Corp.	El Monte, Calif.
EWC	Electrowinders Co., Inc.	Covina, Calif.
GCM	General Cement Mfg. Co.	Rockford, Ill.
KT	Kin Tel	San Diego 12, Calif.
LTF	Littlefuse, Inc.	Des Plaines, Ill.
MAL	P. R. Mallory Co., Inc.	Indianapolis, Ind.
MEP	Mepco, Inc.	Morristown, N. J.
REC	International Rectifier Corp.	El Segundo, Calif.
SFE	San Fernando Electric Mfg. Co.	San Fernando, Calif.
TEX	Texas Instruments, Inc.	Dallas, Texas



7. COMPONENTS IN THE 200 SERIES NUMBERS ASSEMBLE ON 8077020.
6. COMPONENTS IN THE 300 SERIES NUMBERS ASSEMBLE ON 8077022.
5. DENOTES CHASSIS GROUND.
4. ALL CAPACITORS 400 VOLTS.
3. ALL CAPACITANCE IN MICROFARAD
2. ALL RESISTORS 1/2W, ±5%.
1. ALL RESISTANCES IN OHMS.

NOTES: UNLESS OTHERWISE SPECIFIED

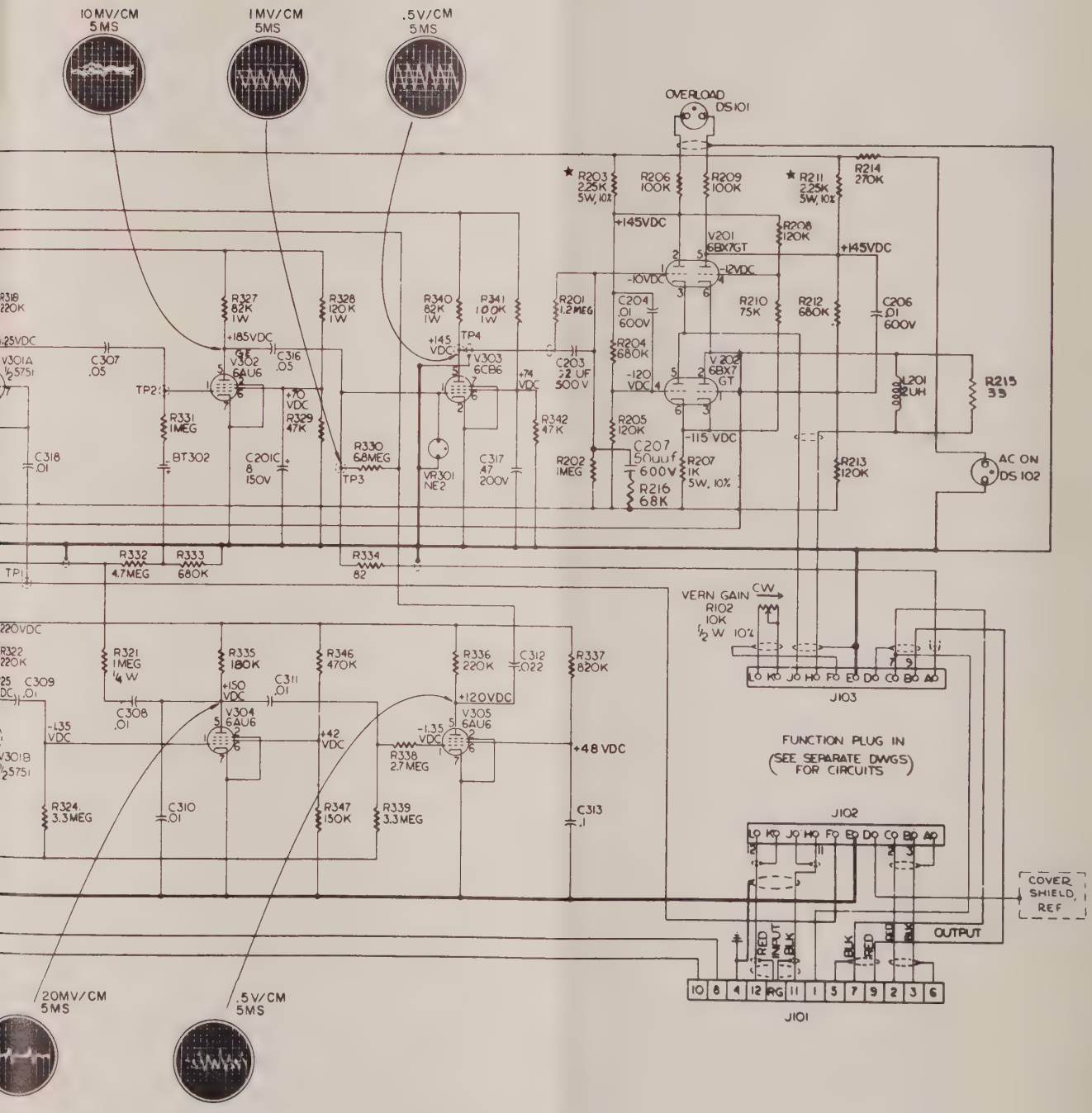
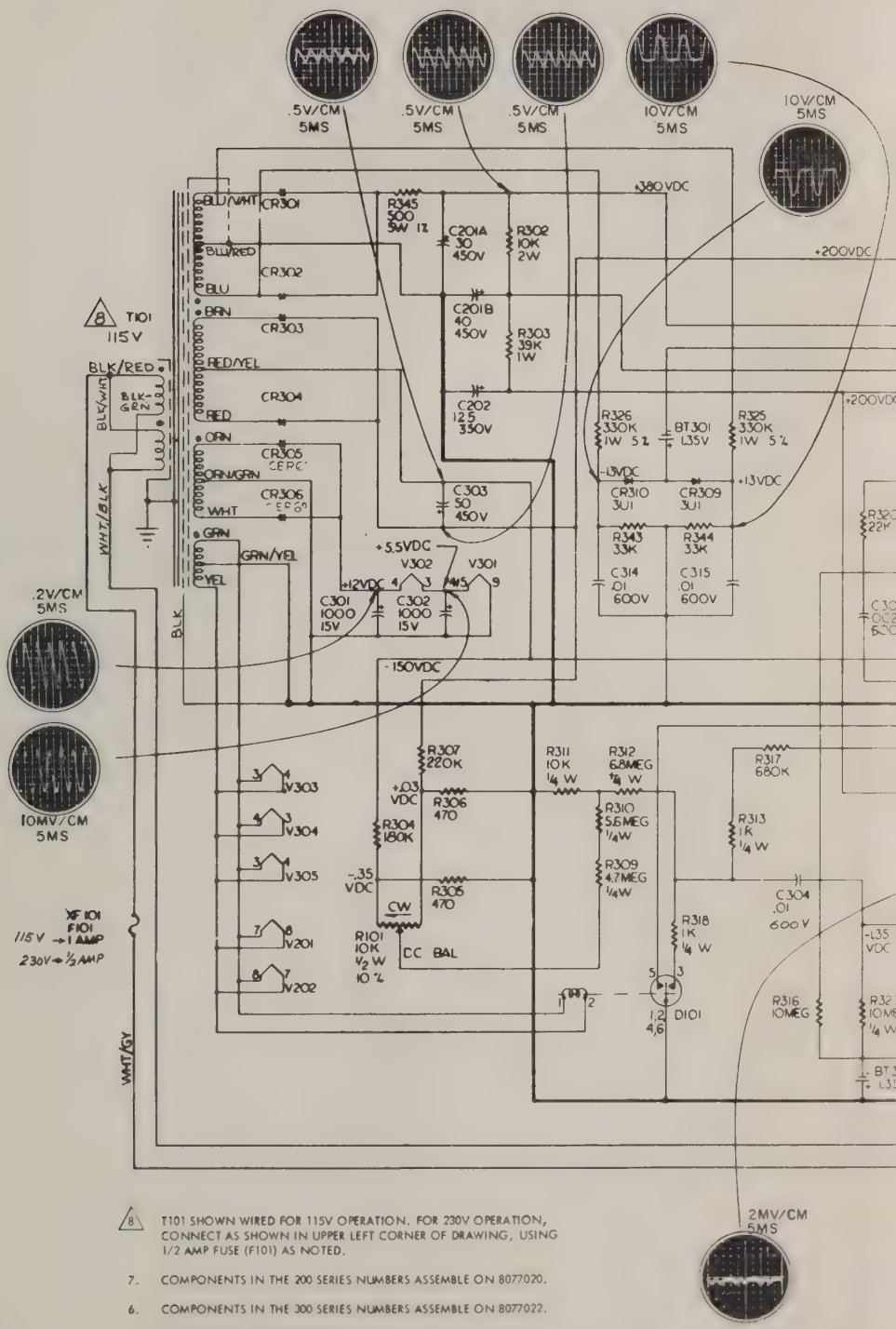


Figure 4-32. Schematic Diagram: Model 112A Wideband DC Amplifier (Dwg. No. 8077100S, Serial Nos. 1-0001 through 1-2700)



8. T101 SHOWN WIRED FOR 115V OPERATION. FOR 230V OPERATION, CONNECT AS SHOWN IN UPPER LEFT CORNER OF DRAWING, USING 1/2 AMP FUSE (F101) AS NOTED.
7. COMPONENTS IN THE 200 SERIES NUMBERS ASSEMBLE ON 8077020.
6. COMPONENTS IN THE 300 SERIES NUMBERS ASSEMBLE ON 8077022.
5. DENOTES CHASSIS GROUND.
4. ALL CAPACITORS 400 VOLTS.
3. ALL CAPACITANCE IN MICROFARAD.
2. ALL RESISTORS 1/2W, ±5%.
1. ALL RESISTANCES IN OHMS.

NOTES: UNLESS OTHERWISE SPECIFIED

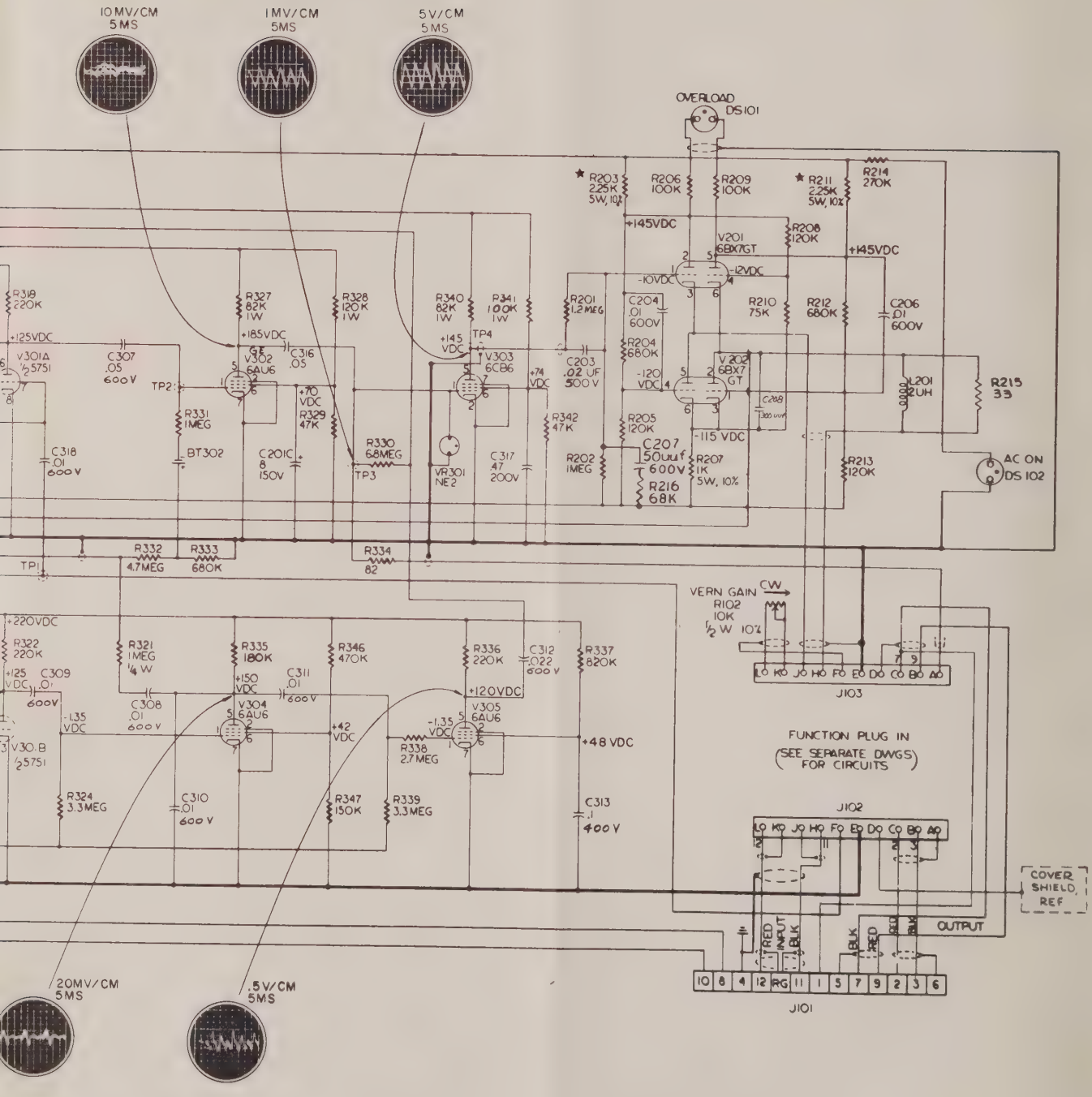


Figure 4-33. Schematic Diagram: Model 112A Wideband DC Amplifier (Dwg. No. 8077101D, Serial Nos. 1-2701 and above)

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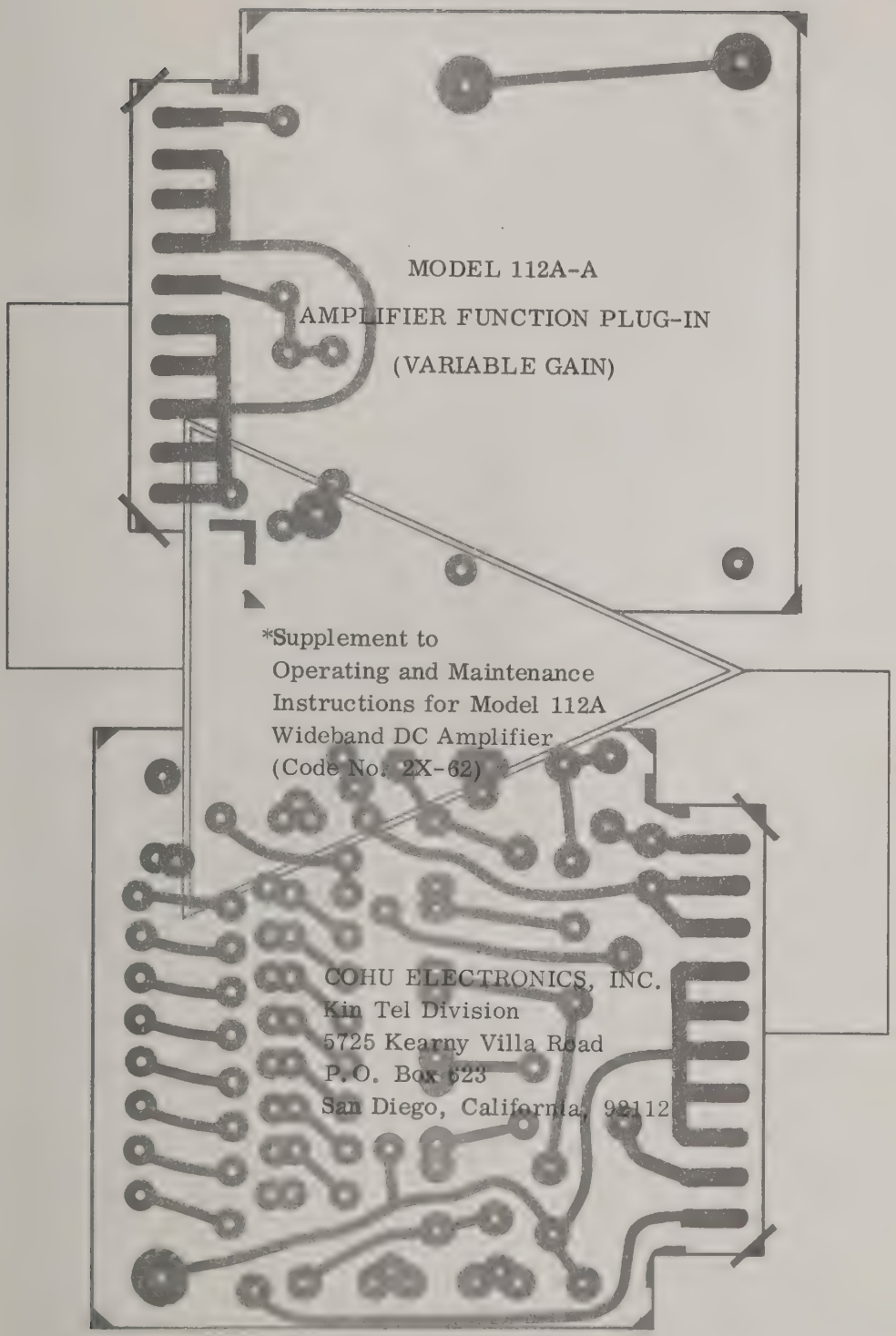

MODEL 112A-A
AMPLIFIER FUNCTION PLUG-IN
(VARIABLE GAIN)

*Supplement to
Operating and Maintenance
Instructions for Model 112A
Wideband DC Amplifier
(Code No. 2X-62)

COHU ELECTRONICS, INC.
Kin Tel Division
5725 Kearny Villa Road
P.O. Box 623
San Diego, California, 92112

ISSUED 1 DECEMBER 1963

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Section I
GENERAL DESCRIPTION

1-1 INTRODUCTION

1-2. KIN TEL Model 112A Series Function Plug-Ins are specifically designed for insertion into and use with the KIN TEL Model 112A Wideband DC Amplifier.

1-3. When in use, a Function Plug-In is physically and electronically a component assembly of the particular Model 112A amplifier in which it is installed. However, the diversity of these plug-in units is such that each requires specific instruction manual coverage for purposes of operation and maintenance, and certain differences in operational theory exist among the various units.

1-4 IDENTIFICATION

1-5. The KIN TEL Model 112A-A Function Plug-In -- when installed in a Model 112A amplifier -- provides for that amplifier an overall circuit configuration presenting gain selection through 11 fixed ranges and permitting continuous variation of more than 6 db over the selected gain position on all ranges. Additionally, the Model 112A-A permits precision gain setting to the limit of measurable accuracy, due to the incorporation of a special Micro-Gain control.

1-6 PHYSICAL DETAILS

1-7. The Model 112A-A (Figure A1-1) is a modular attenuator assembly enclosed in a high-impact styrene cover. It is mounted on a finished panel which -- when installed for use -- becomes the lower half of the front panel of the Model 112A amplifier into which it is inserted. The panel incorporates a handle which consequently becomes the handle of the amplifier, and an adjustable-pawl latch at the bottom of the panel which becomes the amplifier-to-housing lock.

1-8. The skirted control knob on the front panel provides selection of the desired gain range. The panel orifice above this knob allows access to the Micro-Gain control behind the panel.

1-9. From slots in the rear of the styrene module cover, the ends of two etched circuit boards protrude to serve as module-connecting plugs. One of these is visible in Figure A1-1.

1-10 OPERATING CHARACTERISTICS

1-11. The Model 112A-A controls the overall amount of feedback applied throughout the amplifier in which it is installed (with consequent control of

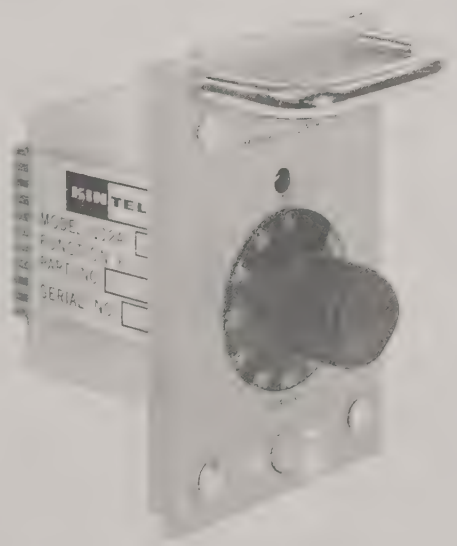


Figure A1-1. Model 112A-A Function Plug-In

overall amplifier gain), and apportions stabilizing signals to control amplifier characteristics.

1-12 OUTLINES AND DIMENSIONS

1-13. Dimensions and outlines of the Model 112A-A are shown in Figure A1-2. Dimensions and outlines of the Model 112A Wideband DC Amplifier with Model 112A-A Function Plug-In installed appear in Figure 1-9 of the manual for the amplifier (Code No. 2X-62).

1-14 SPECIFICATIONS

1-15. The mechanical specifications of the Model 112A-A Function Plug-In are listed in Table A1-1.

1-16. Table A1-2 indirectly provides electrical specifications for the Model 112A-A by tabulating performance specifications of the Model 112A Wideband DC Amplifier with the Model 112A-A Function Plug-In installed.

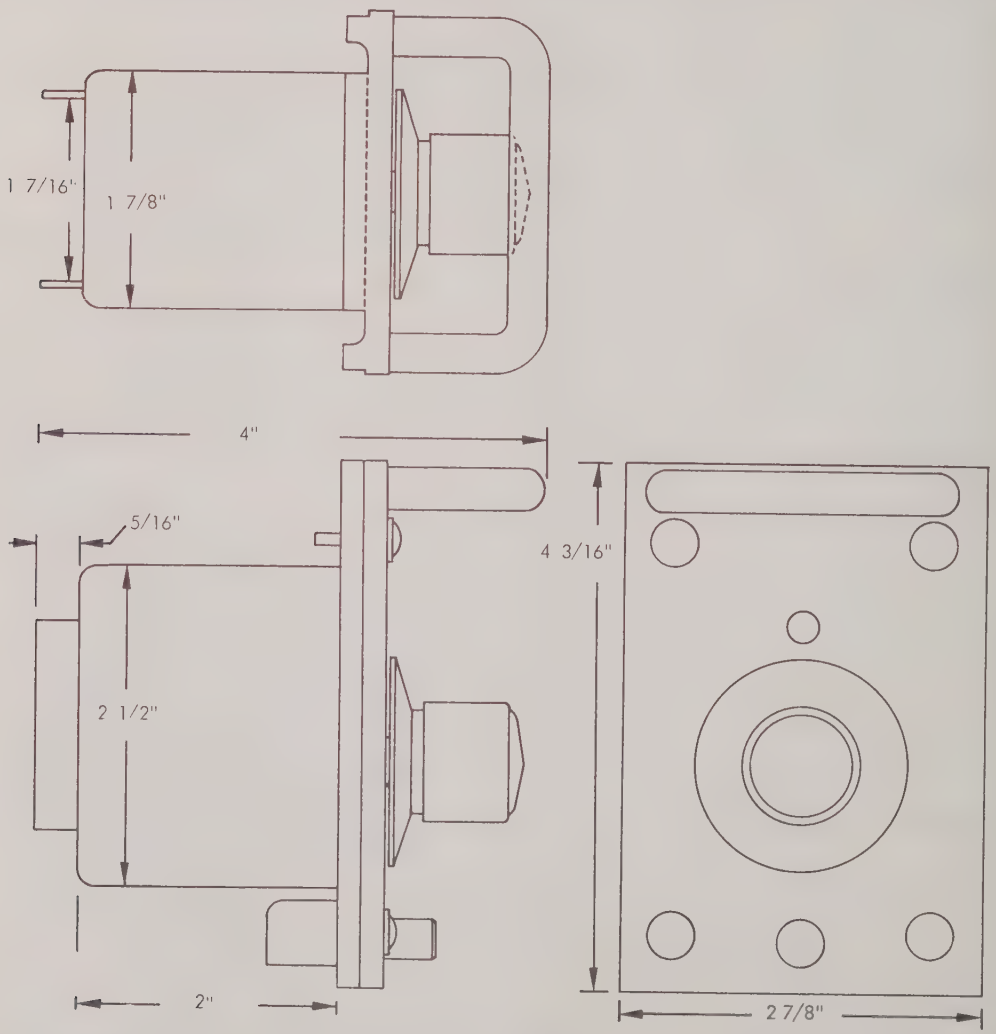


Figure A1-2. Outlines and Dimensions, Model 112A-A Function Plug-In

Table A1-1. Mechanical Specifications: Model 112A-A Function Plug-In

FUNCTION	Provides controlled variation of gain (over 10 stepped ranges) for the Model 112A Wideband DC Amplifier; becomes a functional part of the amplifier front panel; furnishes for the amplifier a drawer-type handle; provides a latch for securing the amplifier in its special housing
CONNECTORS	Gold etched circuits on each of two boards are aligned to connect with printed circuit connectors in the modular receptacle of the amplifier
INSULATION	High-impact styrene cover insulates and protects etched circuitry and components of the assembly, and furnishes positive guidance for effecting the plug-in connection
WEIGHTS (In Pounds)	Net: 1-1/8; Shipping: 2
DIMENSIONS	(See Figure A1-2)

Table A1-2. Specifications: Model 112A Wideband DC Amplifier with the Model 112A-A Gain Plug-In Unit Installed

GAIN (Phase Inverting)	Steps of 0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000, with continuous 1 to 2 times variation of each step by potentiometer
GAIN ACCURACY	±0.5% to 2 kc (Micro-Gain adjustment permits setting individual gain steps to better than ±0.01% accuracy.)
GAIN STABILITY	0.1%
INPUT IMPEDANCE	100,000 ohms
OUTPUT IMPEDANCE	Less than 1 ohm in series with 25 microhenries
EQUIVALENT INPUT DRIFT (After Warmup)	Less than ±2 microvolts for 400 hours or more when used with regulated line voltage, ±10% change in AC line input causes less than ±5 microvolt change
EQUIVALENT INPUT NOISE	0 to 3 cps, less than 5 microvolts peak to peak, 0 to 750 cps, less than 5 microvolts RMS; 0 to 50 kc, less than 12 microvolts RMS
CHOPPER INTERMODULATION	Less than 0.1%
MAXIMUM OUTPUT CABLE CAPACITY	1 microfarad (external)
LINEARITY	Better than 0.05% to 1 kc and 0.1% to 2 kc to full output, better than 0.01% at DC to full output
FREQUENCY RESPONSE	±0.5% to 2 kc, ±3% to 10 kc, less than 3 db down at 40 kc
RISE TIME	Less than 10 microseconds to within 10% of final value
PHASE SHIFT	Less than 5° to 2 kc
OVERLOAD RECOVERY TIME	Less than 3 seconds
LEAKAGE RESISTANCE BETWEEN CHASSIS AND SIGNAL GROUND	The impedance between the amplifier chassis (connector pin 4) and the signal common leads (connector pins 1 and 11) exceeds 50 megohms at DC and .5 megohms at 60 cycles for floating operation

Section II
OPERATION

2-1 UNPACKING

2-2. Packing procedures for the KIN TEL Model 112A-A Function Plug-In will vary according to the items with which they are shipped.

2-3. When shipped with a Model 112A Wideband DC Amplifier, the plug-in usually will be installed in the amplifier, especially if the amplifier is in turn installed in a Model 195 Cabinet (because the amplifier is locked in the cabinet by the latch on the plug-in panel).

2-4. When shipped individually or in a lot shipment of plug-ins, the Model 112A-A is individually wrapped and enclosed in padding; then packed in additional surrounding padding in the shipping container. Corrugated paper shock pads provide additional insurance against damage by crushing or penetration.

2-5. Plug-ins which are shipped with -- but not installed in -- amplifiers, are wrapped as described in paragraph 2-4 and will be placed in the upper portion of the amplifier shipping container, isolated from the amplifiers with the same corrugated shock pads as are used to cover them when shipped separately.

2-6. After the Model 112A-A is removed from its shipping container, a very thorough inspection should be made to discover any possible damage which may have been incurred during shipment. If damage is noted, immediate claim should be filed with the carrier, stating the extent of damage.

NOTE

Operational tests should be made as soon after receipt of equipment as can be arranged, to check for possible damage not apparent on inspection.

2-7 INSTALLATION

2-8. For convenient installation of the Model 112A-A Function Plug-In, the associated amplifier may be in either of two positions: If the amplifier is already installed in its housing, it need not be removed to insert the plug-in. Conversely, it is more often convenient to install the amplifier in its housing to partially restrict its movement while inserting and securing the plug-in (Figure A2-1). When it is more expeditious to install the plug-in unit in an unhoused amplifier, it may be

Figure A2-1. Installing Plug-In with Amplifier in Housing

placed in any convenient position if the amplifier is steadied with one hand while the plug-in is inserted with the other. (See Figure A2-2).

NOTE

Before installing plug-in, examine the unit and the amplifier to be sure no packing material has remained on either.

2-9. The following procedure is used for plug-in installation:

a. Grasp left and right plug-in panel edges and insert plug-in such that the latch is at the bottom of the amplifier facade, and the handle in the center, as shown in Figures A2-1 and A2-2.

b. Engage panel-retaining screws with screwdriver and tighten -- a small amount each time -- alternating among the four screws until all are tight. The screws are retained at the rear of the panel, preventing loss while changing plug-ins and during their storage. (See Figure 2-16 in the manual for the Model 112A amplifier.)

Figure A2-2. Installing Plug-In with Amplifier on Bench

Section III
TEST PROCEDURES

3-1 INTRODUCTION

3-2. With the exception of resistance measurements, significant tests of the Model 112A-A Function Plug-In can be made only when installed in the Model 112A Wideband DC Amplifier. Consequently, these tests are significant of amplifier performance as well as plug-in acceptability.

3-3. Because testing of amplifier operation will largely depend upon the choice of function plug-in, the data which follows will be vital to any testing of the Model 112A amplifier while the Model 112A-A is the plug-in being used.

3-4 TEST EQUIPMENT

3-5. Test equipment required for complete testing of the Model 112A Wideband DC Amplifier with Model 112A-A Function Plug-In is as follows:

AC Vacuum
Tube Voltmeter: Hewlett-Packard Model 400D or equivalent (.0001 to 300 volts)

AC Voltage
Regulator: Sorenson Model 1000S or equivalent or General Radio Model W5MT or equivalent

Audio Oscillators: Hewlett-Packard Model 201C and 200CD or equivalents

Electronic Micro-
voltmeter: KIN TEL Model 203AR or equivalent

Multimeter: Hewlett-Packard Model 410B or equivalent

Oscilloscope: Hewlett-Packard Model 130A or equivalent (0.1mv/cm sensitivity)

Recorder: Esterline-Angus Model AW or equivalent

Test Bridge: KIN TEL Model 112T (Refer to paragraph 3-6)

Cable: Sufficient for test connections as outlined in text

Test Connectors: General Radio Type 274 MB

Miscellaneous: 1.8-ohm 5-watt resistor and an adequately rated SPDT switch to detour one side of AC line through the resistor.

3-6. The Model 112T Test Bridge is a precision instrument specifically designed for testing of KIN TEL DC Amplifiers. It provides proper loading and bandpass filtering and allows the analysis of intermodulation and phase distortion. Model 112T attenuators are of the extreme accuracy required for checking the highly accurate attenuation provided by the Model 112A-A and other 112A Series Function Plug-Ins.

3-7. TEST MODULES. If a number of amplifiers are to be tested, it is usually advisable to prepare an amplifier housing with connections for testing as shown in Figure A3-1; for drift tests, another housing is prepared (connected as shown in Figure A3-2).

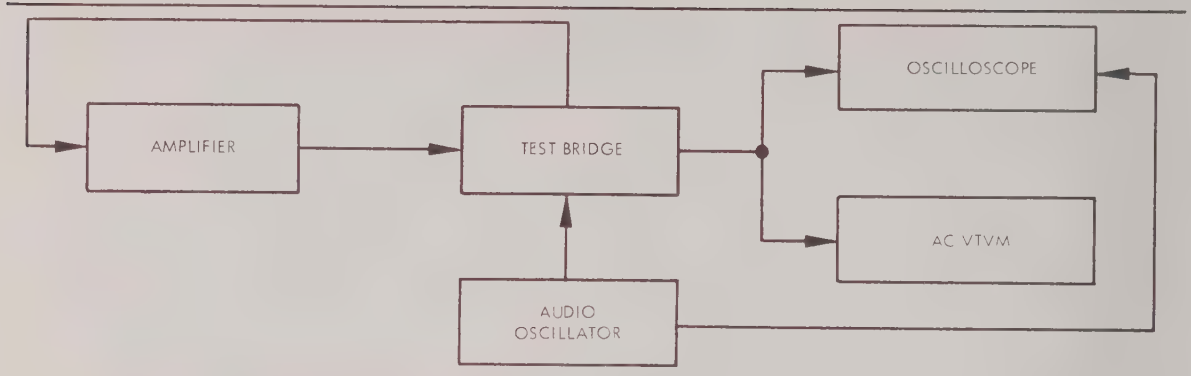


Figure A3-1. Block Diagram of Test Bridge Setup

3-8 TESTING PROCEDURE

3-9. TEST CONDITIONS. The following conditions must prevail during tests:

a. Temperature: Ambient temperatures during tests should be the same as those of the installation in which the amplifier normally operates.

b. Line Voltage: Where not stated otherwise, line should be regulated at a stable 117 volts.

c. Loading: Amplifier should operate into 1000 ohms unless otherwise stipulated.

d. Gain Setting: Gain should be set at 1000 unless otherwise stipulated. Test bridge gain setting must agree with amplifier gain setting at all times unless otherwise stipulated.

e. Input: Amplifier input should be shorted at all times unless a stipulated signal is being applied.

f. Balance: DC BAL. control must be adjusted to provide zero output when input is shorted before any dynamic tests are made.

g. Plug-In: All tests will be made with the Model 112A-A installed in the amplifier.

3-10. STATIC TESTS. Disconnect the amplifier from the AC line by removing it from its housing. With the multimeter, measure resistances between terminals of the connector on the rear of the amplifier chassis. Log readings as shown in Figure A3-3.

3-11. DYNAMIC TESTS. Results of the dynamic tests described in the following paragraphs should be logged on a form such as that shown in Figure A3-4.

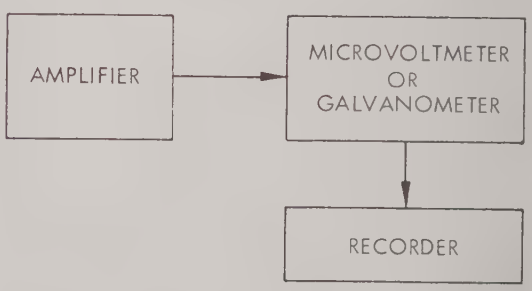


Figure A3-2. Block Diagram of Drift Test Setup

NOTE

The absence of a test listing on the sample test data sheet in Figure A3-4 does not advise its omission from the procedure. Also, chronology of listing in the sample sheet is not necessarily that to be used.

3-12. Initial tests for noise require either a test bridge module or a test setup as illustrated in Figure A3-5.

3-13. NOISE TEST -- 50 KC. Noise in the frequency spectrum of DC to 50 kc is measured by setting the OUTPUT FILTER switch of the test bridge to 50 kc and shorting the amplifier input by setting the test bridge GAIN switch to zero (which setting is retained through all noise tests). VTVM readings are taken at each GAIN switch setting of the Model 112A with the VERN. GAIN pot turned fully CCW. In all cases, the reading shall be less than 12 microvolts (rms) equivalent input.

3-14. NOISE TEST -- 750 CPS. Noise in the frequency spectrum of DC to 750 cps is measured by setting the OUTPUT FILTER switch of the test bridge to 750 cps. Other bridge settings remain the same as in the 50-kc test. VTVM readings are taken with the amplifier GAIN switch set on the x1000 range and with VERN. GAIN pot fully CCW. Noise level shall read less than 5 microvolts (rms) equivalent input.

TEST DATA SHEET

DATE	SERIAL NO.		CHECKED BY	
	From Pin	To	Actual Ohmmeter Reading (In Ohms)	Should Be
	1	5, 7, 11		ZERO
	1	2, 3, 4, 6, 8, 10		INF
(Checked with gain switch set at X20 or above)	4	all terminals		INF
	4	chassis		ZERO
	8	10		5
	11	12		500K
	1	9		9K
(With gain switch at "0")	1	9		ZERO

Figure A3-3. Sample Test Data Sheet for Static Tests

Date_____ Serial No. _____ Checked by_____

		SPECIFICATIONS
NOISE (ref. paragraphs 3-13 through 3-16)		
(50 kc in; VERN GAIN fully CCW)	x1000_____x700_____x500_____x300_____x200_____ x100_____x70_____x50_____x30_____x20_____	≤12 μv RMS eq. input
(750 cps in)	x1000 (VERN CCW)_____	≤5 μv RMS eq. input
(3 cps in)	x1000 (VERN CCW)_____	
LINEARITY (ref. paragraphs 3-23 through 3-33)		
(2 kc; 1000 Ω load)	x1000_____x20_____	Distorts at > 25V RMS
(2 kc; 100 Ω load)	x1000_____	Distorts at > 2.8V RMS
GAIN ACCURACY (I) (ref. paragraphs 3-17, 18, 19)		
(2 kc; 15V RMS; 1000 Ω load)	x1000_____x700_____x500_____x300_____x200_____ x100_____x70_____x50_____x30_____x20_____	≤±1% comp. gain error
OUTPUT IMPEDANCE CHECK (ref. paragraphs 3-20, 21, 22)		
(2 kc; 1.5V RMS; 100 Ω load)	x1000_____	≤±1% comp. gain error
GAIN ACCURACY (II) (ref. paragraph 3-21)		
(10 kc; 15V RMS; 1000 Ω load)	x1000_____x700_____x500_____x300_____x200_____ x100_____x70_____x50_____x30_____x20_____	≤±3% comp. gain error
100% OVERLOAD RECOVERY (ref. paragraph 3-34)		
(2 kc; 10V RMS; 1000 Ω load)	x1000_____seconds	≤3 seconds
CHOPPER INTERMODULATION (ref. paragraphs 3-35, 36)		
(60 cps; 10V RMS; 1000 Ω load)	x1000_____% of output (P-P)	±0.1% P-P output

Figure A3-4. Sample Test Data Sheet for Dynamic Tests

3-15. NOISE TEST -- 3 CPS. Noise in the spectrum DC to 3 cps is measured by setting the OUTPUT FILTER switch of the test bridge to 3 cps. The oscilloscope is used as the indicating instrument. For this test ONLY, the vertical leads of the scope are to be connected to the FILTER OUTPUT terminals of the test bridge. Amplifier GAIN is to be set on the x1000 range and the amplifier VERN. GAIN set fully CCW. The noise level reading shall be less than 5 microvolts (p-p) equivalent input.

3-16. LINE VOLTAGE NOISE TEST. Line voltage noise effects may be duplicated by suddenly switching a 1.8-ohm 5-watt resistor into series with the regulated line to provide a sudden 1-volt (rms) change in the AC source for the amplifier -- all other conditions may remain the same as in the 3-cps noise test. Deflection on the oscilloscope should not exceed 5 microvolts (p-p) equivalent input.

3-17. GAIN ACCURACY TESTS. For testing gain accuracy of the Model 112A, the recommended audio oscillator is added to the test setup (Figure A3-6) and the input short removed. Signals of selected frequency may thus be applied to the EXTERNAL INPUT of the test bridge and the horizontal input of the oscilloscope.

3-18. Set the oscillator to apply a 2-kc signal of 15 volts (rms). Check the amplifier output waveform on the scope while changing gain settings of both amplifier and bridge, step-by-step through all gain ranges. (The scope should indicate a 15-volt (rms) signal on all ranges.)

3-19. On each gain range, adjust the PHASE dial of the test bridge to obtain the narrowest pattern on the oscilloscope. Adjust the GAIN ERROR dial to align the pattern horizontally with the X-axis of the oscilloscope. Convert dial readings to percentages

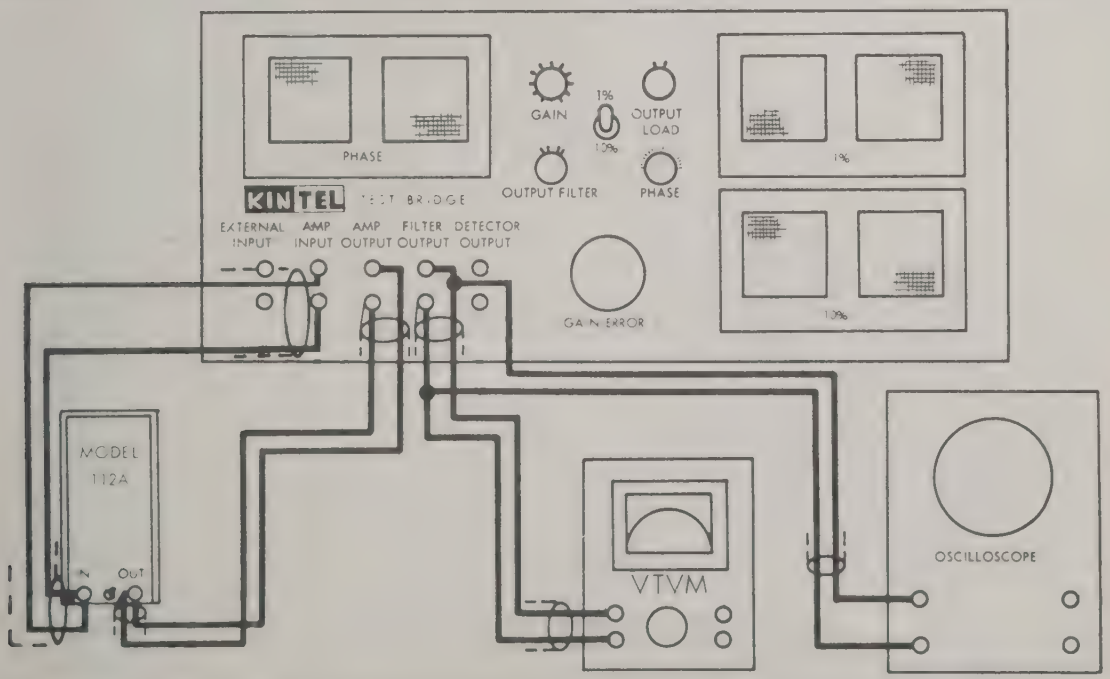


Figure A3-5. Equipment Connections for Noise Test Setup

by means of the charts on the test bridge panel. Gain error and phase error must be added algebraically to obtain the composite gain error. (phase readings are negative; GAIN ERROR dial position determines the sign of the gain error -- positive if to the right of the zero, negative if to the left.) The computed total is a true gain error which must not exceed ±1 percent. If gain error exceeds ±1 percent, adjust Micro-Gain control to provide minimum gain error -- based on average of gain error on all ranges. Note that the 1-percent switch position and the 1-percent chart should be used where possible. If necessary, the 10-percent switch position and the 10-percent chart may be used. Phase readings are converted by use of the 2-kc chart when the applied signal is of that frequency. Later tests employing a 10-kc signal will require the use of the 10-kc chart for conversion of phase readings.

3-20. OUTPUT IMPEDANCE TEST. Set the OUTPUT LOAD switch of the test bridge to the 100-ohm position, and reduce the output of the audio oscillator to 1.5 volts (rms) as read on the VTVM. Set GAIN switches of amplifier and test bridge on the x1000 range, and amplifier VERN. GAIN control at the fully CCW position. Adjust PHASE and GAIN ERROR as required, convert dial readings, and compute total composite gain error, which should not exceed ±1 percent (an output impedance of approximately 1 ohm).

3-21. Reset the audio oscillator to provide a 10-kc 15-volt signal, and reset the test bridge OUTPUT LOAD switch to the 1000-ohm position. With amplifier VERN. GAIN pot fully CCW, "walk" the amplifier and test bridge through all gain ranges, and in each range follow the procedure in paragraph 3-19. In this case, composite gain error must not exceed ±3 percent.

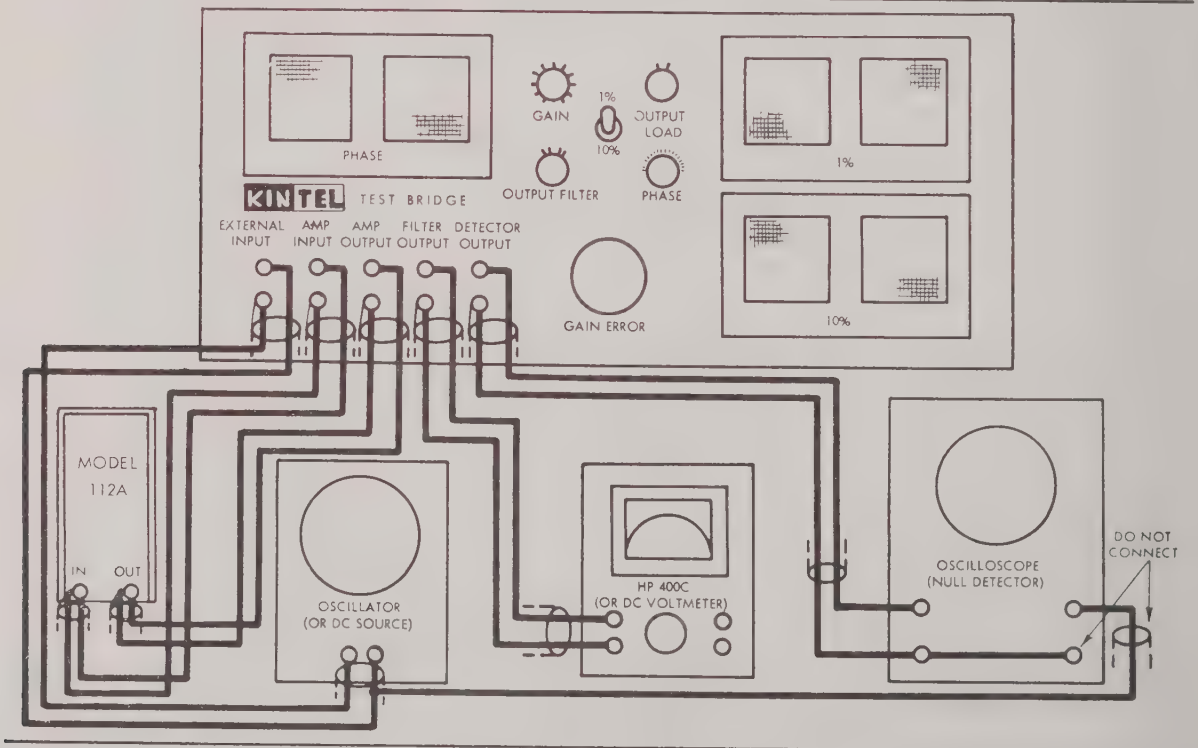


Figure A3-6. Equipment Connections for Testing Gain Accuracy

3-22. At this point, a check may be made to determine actual gain as related to VERN. GAIN pot setting. Set the amplifier and test bridge GAIN switches on the x500 range; leave VERN. GAIN pot in the fully-CCW position. Remove oscilloscope leads from DETECTOR OUTPUT and connect to AMPLIFIER OUTPUT terminals. Adjust scope controls to place waveform perimeter at definite dial-scale boundaries. Note this amplitude. Change test bridge GAIN setting to x1000 and turn amplifier VERN. GAIN pot fully CW; amplitude of the scope signal should be slightly greater than noted before this change in control settings.

NOTE

Test setup may be used to find the exact setting of the VERN. GAIN pot which exactly doubles a given range setting. With amplifier (and test bridge) GAIN switch set to the range which is to be so doubled during operation, and with VERN. GAIN pot turned fully CCW, connect scope leads to the DETECTOR OUTPUT bridge terminals, set scope controls and bridge PHASE dial to obtain waveform as shown in Figure A3-7. Note that scope amplitude is set to place waveform perimeter at definite dial-scale boundaries. Change test bridge GAIN setting to exactly twice that of the amplifier, and turn VERN. GAIN control fully CW. Set GAIN ERROR dial of the test bridge to zero, and alternately adjust PHASE dial and VERN. GAIN pot until waveform is within the same boundaries as before the change in gain settings (as in Figure A3-7). Note that this position of the VERN. GAIN pot may not be exactly the same as for doubling the gain in another set gain range.

3-23. LINEARITY TEST -- 1000-OHM LOAD. For testing linearity, connect the VTVM and the oscilloscope vertical input to the EXTERNAL INPUT of the test bridge (paralleling the oscillator connections). See Figure A3-8. Set bridge OUTPUT LOAD at 1000 ohms. Adjust oscillator to apply a 2-kc 25-volt signal (rms indication on VTVM). With scope horizontal gain at zero, adjust vertical gain for full-scale deflection with this signal. Scope is now calibrated at 25V full scale.

3-24. Disconnect vertical scope leads and VTVM from EXTERNAL INPUT terminals and connect them to AMPLIFIER OUTPUT terminals. The only change in the oscilloscope waveform should be a phase reversal.

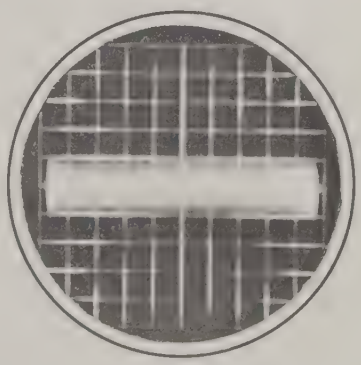


Figure A3-7. Waveform Adjusted to Dial Scale Boundaries

3-25. Leaving VTVM connected to AMPLIFIER OUTPUT connections, move scope vertical leads to DETECTOR OUTPUT. Increase oscilloscope vertical sensitivity by a factor of 100, and set scope horizontal gain for full X-axis deflection. Because only half of the signal appears at the DETECTOR OUTPUT, the oscilloscope will read 2 percent full scale instead of 1 percent.

3-26. Now adjust the PHASE and GAIN ERROR dials for a null indication. The resulting oscilloscope pattern should be approximately as shown in Figure A3-9.

3-27. Distortion (nonlinearity) will be evidenced by a downward hook at the right extremity of the waveform. If any distortion appears, it must not exceed one twentieth of the CRT scale beyond signal perimeter (this would equal 0.1 percent nonlinearity). Figure A3-10 shows a full 0.1 percent distortion which was obtained by increasing the oscillator output to 27 volts and discernible distortion did not begin to appear until oscillator output reached 26.5 volts, indicating adequate margin for linearity specifications.

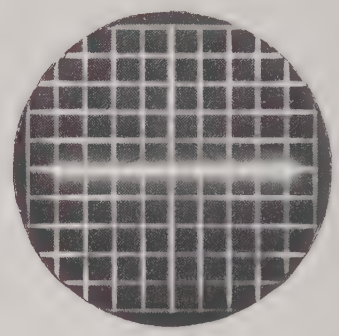


Figure A3-9. Waveform Indicating Normal Linearity (paragraph 3-26)

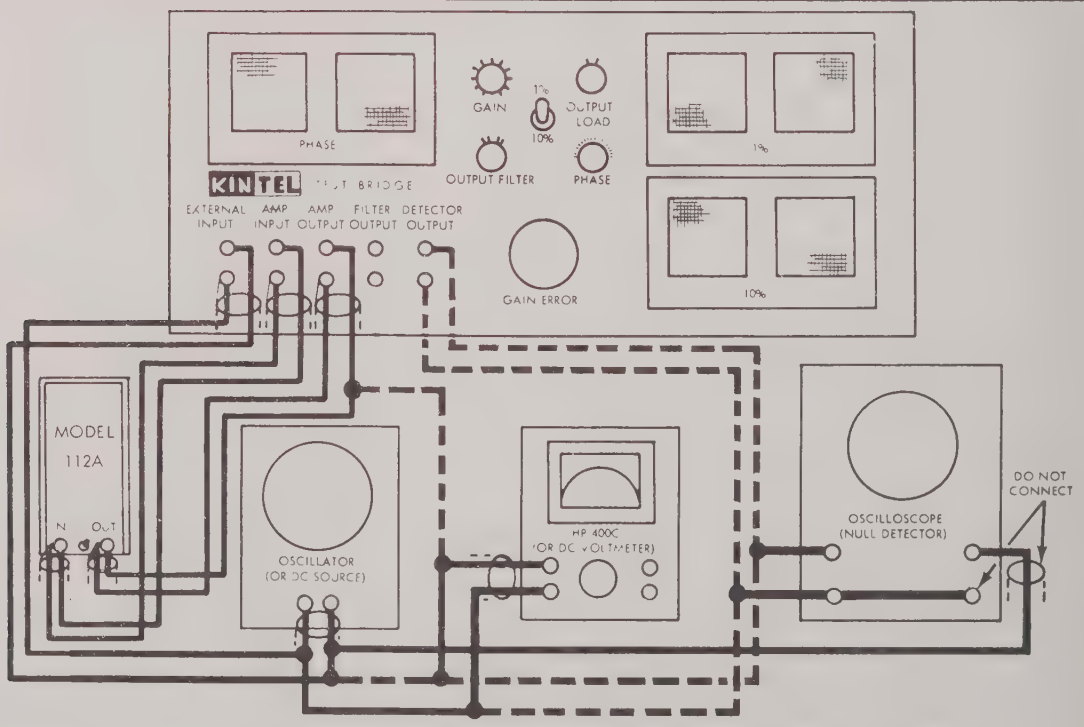


Figure A3-8. Equipment Connection Changes for Linearity Tests

3-28. The output of the Model 112A is 180° out of phase with the input, so the fundamental frequencies -- as they appear at the DETECTOR OUTPUT terminals -- are canceled. The resulting signal is therefore an indication of the peak-to-peak nonlinearity of the amplifier.*

NOTE

This measurement is valid only if oscillator output level remains unchanged after calibrating the oscilloscope (paragraph 3-23).

3-29. This linearity test is performed with VERN. GAIN control fully CCW and amplifier and test bridge GAIN controls always set on the same range and with the same 25-volt (rms) level maintained at all times whatever the range being tested.

3-30. LINEARITY TEST -- 100-OHM LOAD. Connect VTVM and oscilloscope vertical input leads to the EXTERNAL INPUT terminals of the test bridge. See Figure A3-8. Change bridge OUTPUT LOAD setting to 100 ohms. Set audio oscillator output to deliver a 2.8-volt 2-kc signal (rms indication on VTVM). With scope horizontal gain at zero, adjust vertical gain for full-scale deflection with this signal. Scope is now calibrated at 2.8 volts full scale.

3-31. Remove VTVM and scope vertical leads from EXTERNAL INPUT terminals and connect to AMPLIFIER OUTPUT terminals. Excepting phase reversal, waveform should be identical to the previous one (calibration waveform).

3-32. Leaving VTVM connected to AMPLIFIER OUTPUT, move scope vertical leads to DETECTOR OUTPUT. Increase oscilloscope vertical sensitivity by a factor of 100 and set scope horizontal gain for full X-axis deflection. The oscilloscope will indicate 2 percent of full scale instead of 1 percent, because of the factor of two introduced by the test bridge.

3-33. Adjust PHASE and GAIN ERROR dials for a null indication. The scope pattern should be approximately as shown in Figure A3-9. Distortion must not exceed one twentieth of full scale (beyond the perimeter of the actual signal waveform) in order to meet linearity specifications. Amplifier output must be maintained at 2.8 volts to validate this measurement. This test is made with test bridge and amplifier GAIN settings always on the same range and the VERN. GAIN pot fully CCW.

3-34. OVERLOAD RECOVERY TEST. Adjust audio oscillator to provide a 2-kc 10-volt (rms) output. Set the test bridge OUTPUT LOAD switch in the

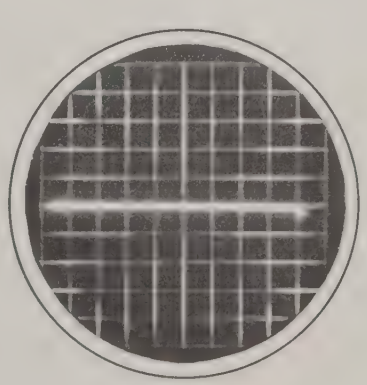


Figure A3-10. Waveform Indicating Non-Linearity (paragraph 3-27)

*Linearity specifications of the Model 112A Amplifier (with 112A-A Plug-In) are stipulated "better than 0.1 percent to 2KC at full output". . peak AC output is rated at 35 volts with a 1000-ohm load. The 25-volt signal used in linearity testing is 35 volts peak.

1000 ohm position, and set GAIN switches of amplifier and test bridge at x1000. Switch the test bridge GAIN control suddenly to the x100 range and hold it there for approximately three seconds; observing a timepiece, return the bridge GAIN switch to the x1000 position. The waveform on the oscilloscope should return to its normal pattern in three seconds or less after switching GAIN back to x1000.

3-35. CHOPPER INTERMODULATION TEST. Remove VTVM and oscilloscope vertical leads from their respective connections and connect them to the EXTERNAL INPUT terminals of the test bridge. With all other conditions remaining as at the end of the Overload Recovery Test, adjust the oscillator to apply a 60-cps 10-volt signal (rms indication on the VTVM). Calibrate the oscilloscope by adjusting the vertical gain to bring the 10-volt signal to full-scale deflection.

3-36. Increase vertical sensitivity of the scope by a factor of 100 and set scope horizontal gain for full X-axis deflection. Movement of the waveform is now so slight that very close observation is required to detect any deviation of a given peak. The area of concern, however, is the peak-to-peak measurement of the signal exclusive of noise. This measurement is made by considering only the top of each peak or the bottom of each peak, as indicated in Figure A3-10. This measurement should not exceed a total of one-twentieth of the CRT dial scale, and is typically less than one-sixtieth of this scale.

3-37. BALANCE TEST. For this test, a drift module test setup (see Figure A3-3) is used, in which the indicating microvoltmeter (set on its 100-mv range) is connected to the amplifier output. With amplifier input shorted and GAIN switch set on the x1000 range (VERN. GAIN fully CCW), rotate the DC BAL. control over its complete range while observing the indication of the metering instrument. The total swing metered during this control rotation should be somewhere in the range of 60 to 90 millivolts. When the meter registers zero, the DC BAL. control should be in the center of its range.

3-38. After this test proves the DC BAL. control to be properly effective over its range, reset the metering instrument to its 10-μv range and readjust the DC BAL. control for zero indication on the meter.

3-39. DRIFT AND SHOCK TESTS. Check amplifier output by reading the recorder after fifteen minutes of recording. Drift should not exceed ±2 microvolts (referred to the input). To test for shock, strike the amplifier housing sharply with the hand. An initial offset may be recorded due to this blow, but the chart should record an immediate return to normalcy.

3-40. TESTING WITHOUT A BRIDGE. Where the number of amplifiers in an installation is not great enough to warrant purchase of a Model 112T Test Bridge, or where testing area limitations or other reasons preclude the use of a bridge, individual amplifiers may be tested to the accuracies permitted by the available testing equipment. Not all of the previously described tests can be performed with the equipment customarily found in a standard electronic laboratory. However, sufficient tests usually can be performed to assure continuance of satisfactory amplifier operation.

3-41. Wideband noise tests may be performed without difficulty, and a simple RC filter (Figure A3-11) may be employed to narrow the bandwidth for 750-cps noise tests. To narrow bandwidth still further for the 3-cps noise tests, substitute a 56K resistor and a 1 μf capacitor for the 22K and .1 μf units shown in Figure A3-11. The oscilloscope may be used to measure 3-cps noise; the VTVM lacks the sensitivity required for this measurement.

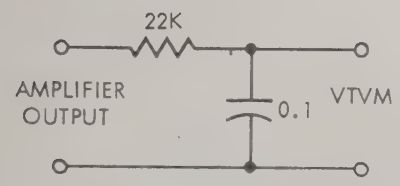


Figure A3-11. 750-Cycle Filter

3-42. The testing of gain accuracy without a test bridge necessitates the construction of high-precision external attenuators. Tests are valid only to the extent of accuracy of the individual components used in the external attenuator, and the accuracy of their relationships. Figures A3-12 and A3-13 illustrate configurations of attenuator and test setup.

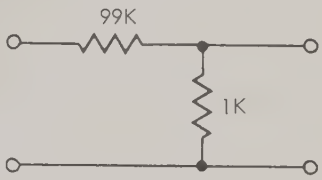


Figure A3-12. Precision Attenuator

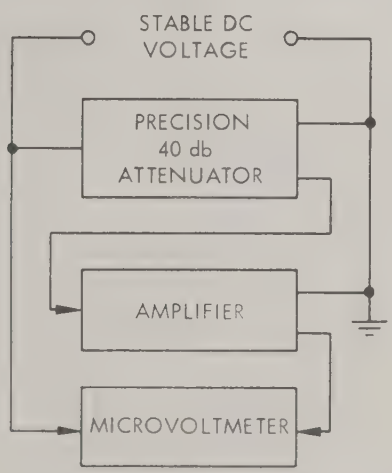


Figure A3-13. Testing Gain Accuracy Without Test Bridge (Paragraph 3-42)

Section IV
MAINTENANCE

4-1 INTRODUCTION

4-2. The Model 112A-A (Figure A4-1) consists of two etched board assemblies, a three-wafer rotary switch, and a miniature potentiometer, and is mounted on a front panel which -- when installed -- becomes the lower front-panel section of the associated amplifier. A high-impact styrene cover provides protection and positions the ends of the etched boards to assure proper plug-in spacing.

4-3. Maintenance should be performed only by qualified, trained technicians. Severe damage may result from repair activities attempted by untrained personnel.

4-4 DISASSEMBLY INSTRUCTIONS

4-5. The Model 112A-A must be disassembled for maintenance. The following procedure must be used:

a. Set GAIN control at zero (0).

b. Loosen the two No. 8 set screws in the knob with a 5/64" hex wrench. Remove knob.

c. Remove the three screws which hold the chassis to the front panel. Lay panel aside.

d. Remove the two screws which secure the styrene cover to the chassis; remove the cover and set aside.

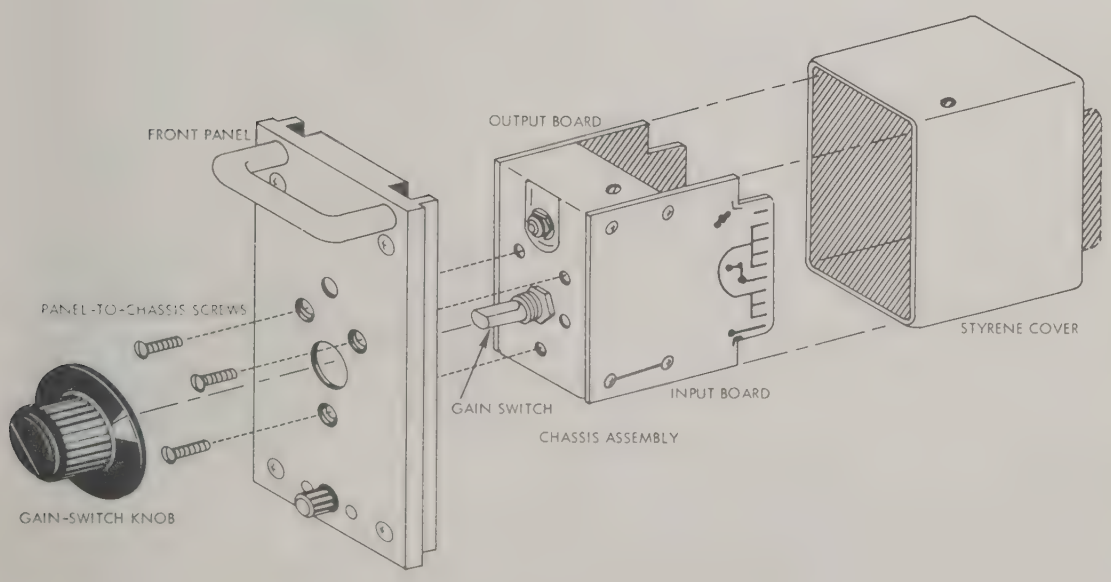


Figure A4-1. Model 112A-A Function Plug-In (Exploded View)

4-6. The attenuator may now be examined, cleaned, or further disassembled for repairs (refer to paragraph 4-14).

4-7 HANDLING PRECAUTIONS

4-8. Every precaution should be taken in handling etched and printed circuitry while servicing. Boards may be contaminated by salts and acids present in the human skin. Such contamination can lower leakage resistance between paths or components mounted on the boards. It is advisable to wear clean cotton gloves when it becomes necessary to handle such circuitry.

4-9 PREVENTIVE MAINTENANCE

4-10. The use of quality epoxy boards and 24-karat bright-gold circuits minimizes maintenance problems normally associated with plug-in etched board circuitry.

4-11. Unlike other solders or alloys used for etched circuit paths, the bright-gold etch on these boards will not tend to wear or migrate. The insertion and removal of etched boards can wear thin such baser metals as standard etching solders, due to the necessarily positive gripping action of the mating connectors, but gold tends to flex and conform, especially when the matching connector fingers are also gold plated.

4-12. CLEANING. Periodic cleaning and inspection should be scheduled to prevent the accumulation of dust, lint, or other airborne pollution which might be detrimental to operation. Cleaning of the function plug-in should be scheduled at the same times as cleaning of the associated amplifier (paragraphs 4-5 and 4-6 in the amplifier manual).

4-13 CORRECTIVE MAINTENANCE

4-14. The disassembly instructions given in paragraphs 4-4 through 4-6 will expose the etched paths of both input and output boards for testing, but if a component must be replaced, the unit must be more completely disassembled. To expose components for removal, the procedure is as follows:

a. Perform disassembly outlined in paragraph 4-5.

b. Remove the four screws (two on each board) which hold the etched boards to the chassis. The input board (at this point attached to the assembly only by the potentiometer lead) is allowed to lie at one side as in Figure A4-2.

c. Remove the nut which holds the switch to the chassis; withdraw the switch shaft from the opening and lay aside the switch-and-output-board assembly as shown in the drawing.

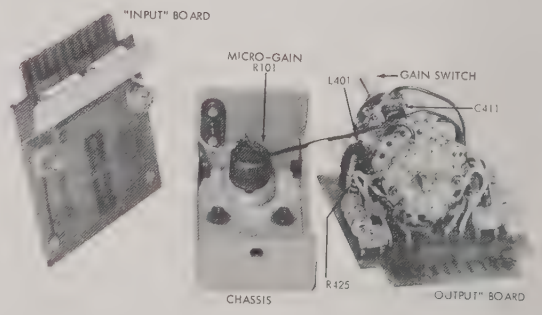


Figure A4-2. Exposing Components for Replacement

4-15. If etched board components are to be replaced, extreme care must be exercised to avoid damaging adjacent components. OBSERVE ALL PRECAUTIONS GIVEN IN THE AMPLIFIER MANUAL (paragraphs 4-11 and 4-12) plus the following:

a. Where space does not permit insertion of cutters on the component side of the board, use small diagonal cutters with unbeveled jaws to undercut solder beneath the crimped end of the lead as in Figure A4-3.

NOTE

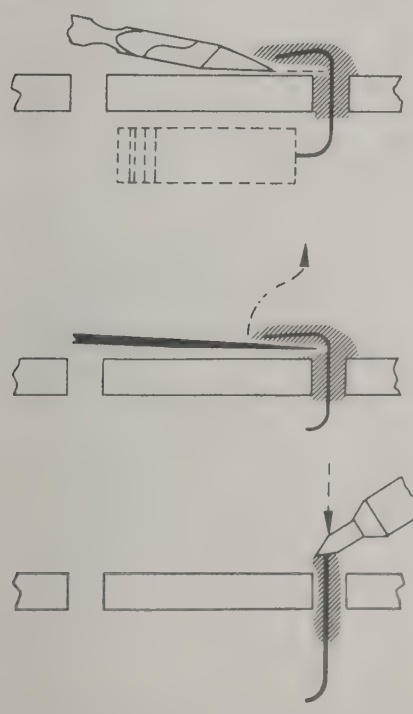
EXERCISE EXTREME CARE TO AVOID DAMAGE TO ETCHED CIRCUIT WHEN CUTTING INTO SOLDER.

b. Use an edged tool to free crimped lead; straighten as illustrated.

c. When both leads of a component have been straightened, carefully heat solder point and push leads through board to free component.

d. To obtain additional space in which to work while inserting replacement components, the switch may be gently pulled away from the board to the extent allowed by the length and flexibility of attached leads. When moving the switch back into place, however, be certain that no lugs are touching uninsulated parts of the circuit or components. See Figure A4-4.

4-16. If facilities or personnel do not permit safe replacement of etched board components, it is recommended that a spare etched board assembly be stocked to avoid down time. In the event of replacement, the removed assembly may be returned to the factory



A. UNDERCUTTING SOLDER TO FREE CRIMPED LEAD (NOTE USE OF FLAT-BOTTOM CUTTER TO AVOID DAMAGE TO ETCHED PATTERN OR BOARD)

B. STRAIGHTENING CRIMPED LEAD WITH AID OF EDGED TOOL (NOTE THAT ANGLE OF INSERTION PROTECTS BOARD AND CIRCUIT FROM TOOL DAMAGE)

C. HEATING STRAIGHTENED LEAD WITH CLEAN, TINNED IRON, USING SLIGHT DOWNWARD PRESSURE TO PUSH LEAD THROUGH BOARD ORIFICE.

Figure A4-3. Removal of Semi-accessible Components (Paragraph 4-15)

for service. Upon return of the repaired assembly, it may be stocked as the replacement spare.

4-17 PART IDENTIFICATION

4-18. Figures A4-1 through A4-6 will aid in locating and identifying component parts of the Model 112A-A Function Plug-In. Use of the schematic diagram (refer to paragraph 4-23) in conjunction with these illustrations will expedite the procedure, particularly when following etched circuit configurations shown in Figures A4-5 and A4-6.

4-19 MAINTENANCE SUPPORT DATA

4-20. Maintenance procedures for the Model 112A-A are supported by the inclusion of data such as resistance measurements, list of replaceable parts, and schematic diagram.

4-21. RESISTANCE READINGS. Table A4-1 lists resistances as measured at pertinent points in the Model 112A-A. Note that many resistors are of only 1/4% tolerance.

4-22. PARTS LIST. Table A4-2 lists the replaceable parts of the Model 112A-A Function Plug-In. Those which are recommended for stocking as spares are marked by an asterisk. The manufacturers are designated by code, and these tabulations may be decoded by reference to the list of Manufacturers' Code Designations (Table A4-3).

4-23. SCHEMATIC DIAGRAM. Figure A4-7 schematically illustrates the circuitry of the Model 112A-A. Note that P102 and P103 in Figure A4-7 mate with J102 and J103, respectively, in Figure 4- of the amplifier manual.

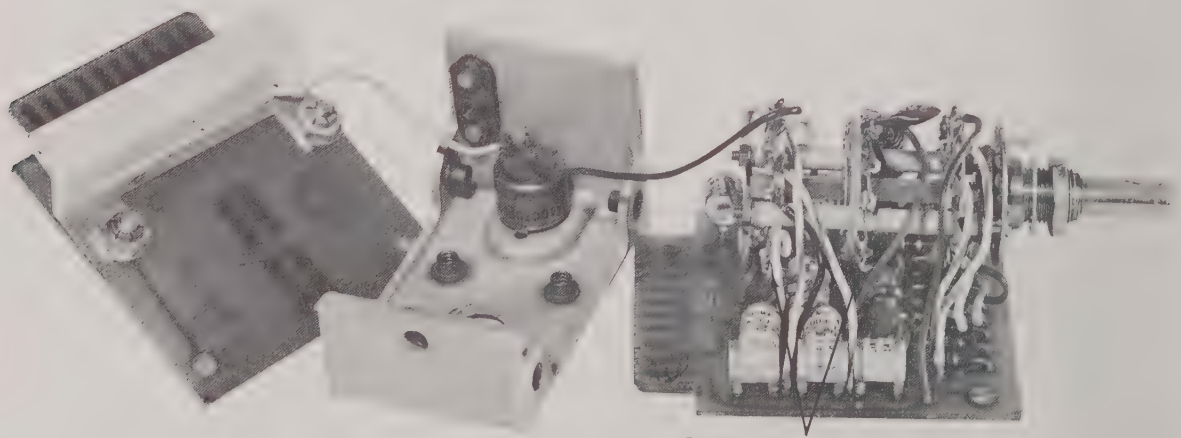


Figure A4-4. Switch Placement for Reassembly, Showing Precautions

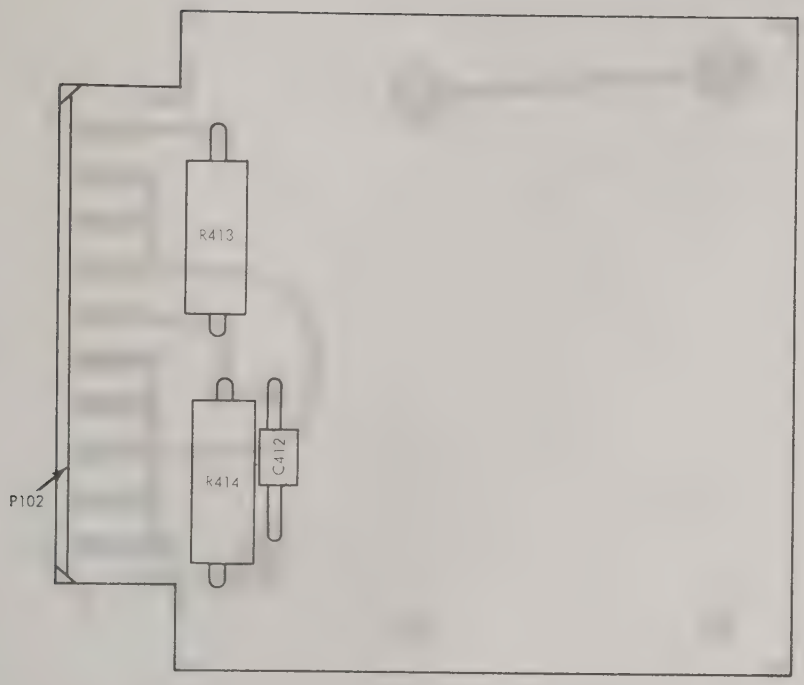


Figure A4-5. "Input" Assembly from Etched Side, Showing Components

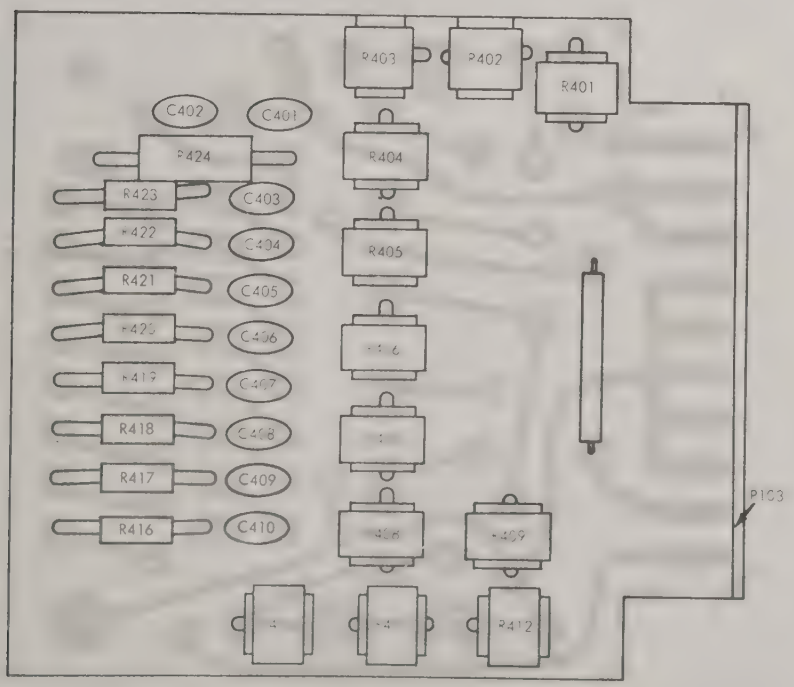


Figure A4-6. "Output" Assembly from Etched Side, Showing Components

Table A4-1. List of Replaceable Parts, Model 112A-A Function Plug-In

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
C401	Ceramic Disc, .001 µf, 600V	EIA	0401046
C402	Ceramic Disc, .002 µf, 600V	EIA	0401048
C403	Ceramic Disc, .001 µf, 600V	EIA	0401046
C404	Ceramic Disc, .001 µf, 600V	EIA	0401046
C405	Ceramic Disc, 680 µµf, 600V	EIA	0401042
C406	Ceramic Disc, 200 µµf, 600V	EIA	0401027
C407	Ceramic Disc, 200 µµf, 600V	EIA	0401027
C408	Ceramic Disc, 100 µµf, 600V	EIA	0401022
C409	Ceramic Disc, 100 µµf, 600V	EIA	0401022
C410	Ceramic Disc, 200 µµf, 600V	EIA	0401018
C411	Ceramic Disc, 680 µµf, 600V	EIA	0401042
C412	Tubular, composition, 3 µµf, 500V, 5%	STP	0406759-029
★ C413	Molded Mica, 100µµf, 500V ±5%	ARC	1010000-027
L401	Coil, choke, 25 µh (+25%, -10%), .1 ohms (+10%, -25%)	EWC	6710011-001
R401	Wirewound, 4.5K ohms, .25%	CIN	4806796
R402	Wirewound, 1.5K ohms, .25%	CIN	4806795
R403	Wirewound, 1.2K ohms, .25%	CIN	4806794
R404	Wirewound, 514.3 ohms, .25%	CIN	4806791
R405	Wirewound, 385.7 ohms, .25%	CIN	4806790
R406	Wirewound, 4.5K ohms, .25%	CIN	4806796
R407	Wirewound, 1.5K ohms, .25%	CIN	4806795

#Refer to Table A4-2.
★Used only in units serially numbered 1-0151 through 1-0200

Table A4-1. List of Replaceable Parts, Model 112A-A Function Plug-In (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR	KIN TEL PART NO.
R408	Wirewound, 1.2K ohms, .25%	CIN	4806794
R409	Wirewound, 1K ohms, .25%	CIN	4806793
R410	Wirewound, 514.3 ohms, .25%	CIN	4806791
R411	Wirewound, 385.7 ohms, .25%	CIN	4806790
R412	Wirewound, 900 ohms, .25%	CIN	4806792
R413	Film, high stability, 100K ohms 1/4W, .5%	AB	5210068-003
R414	Film, high stability, 975K ohms, 1/4W, .5%	AB	5210068-005
R415	Variable, composition, miniature, 50K ohms, 1/2W, 10%	AB	5010181-004
R416	Composition, 3.9K ohms, 1/4W, 5%	AB	4045000-392
R417	Composition, 2.7K ohms, 1/4W, 5%	AB	4045000-272
R418	Composition, 1.8K ohms, 1/4W, 5%	AB	4045000-182
R419	Composition, 1.2K ohms, 1/4W, 5%	AB	4045000-122
R420	Composition, 680 ohms, 1/4W, 5%	AB	4045000-681
R421	Composition, 330 ohms, 1/4W, 5%	AB	4045000-331
R422	Composition, 180 ohms, 1/4W, 5%	AB	4045000-181
R423	Composition, 120 ohms, 1/4W, 5%	AB	4045000-121
R424	Composition, 39 ohms, 1/2W, 5%	AB	0310030-390
R425	Composition, 39 ohms, 1/2W, 5%	AB	0310030-390
S401	Switch, rotary	OAK	6210039-001

#Refer to Table A4-2.

Table A4-2. Manufacturers' Code Designations

CODE	MANUFACTURER	ADDRESS
AB	Allen-Bradley Co.	Milwaukee 4, Wis.
ARC	Arco Electronics, Inc.	New York 13, N. Y.
CIN	Cinema Engineering Co.	Burbank, Calif.
EIA	Any brand meeting EIA standards	
EWC	Electrowinders Co., Inc.	Covina, Calif.
OAK	Oak Manufacturing Co.	Chicago 10, Ill.
STP	Stackpole Carbon Co.	St. Marys, Pa.

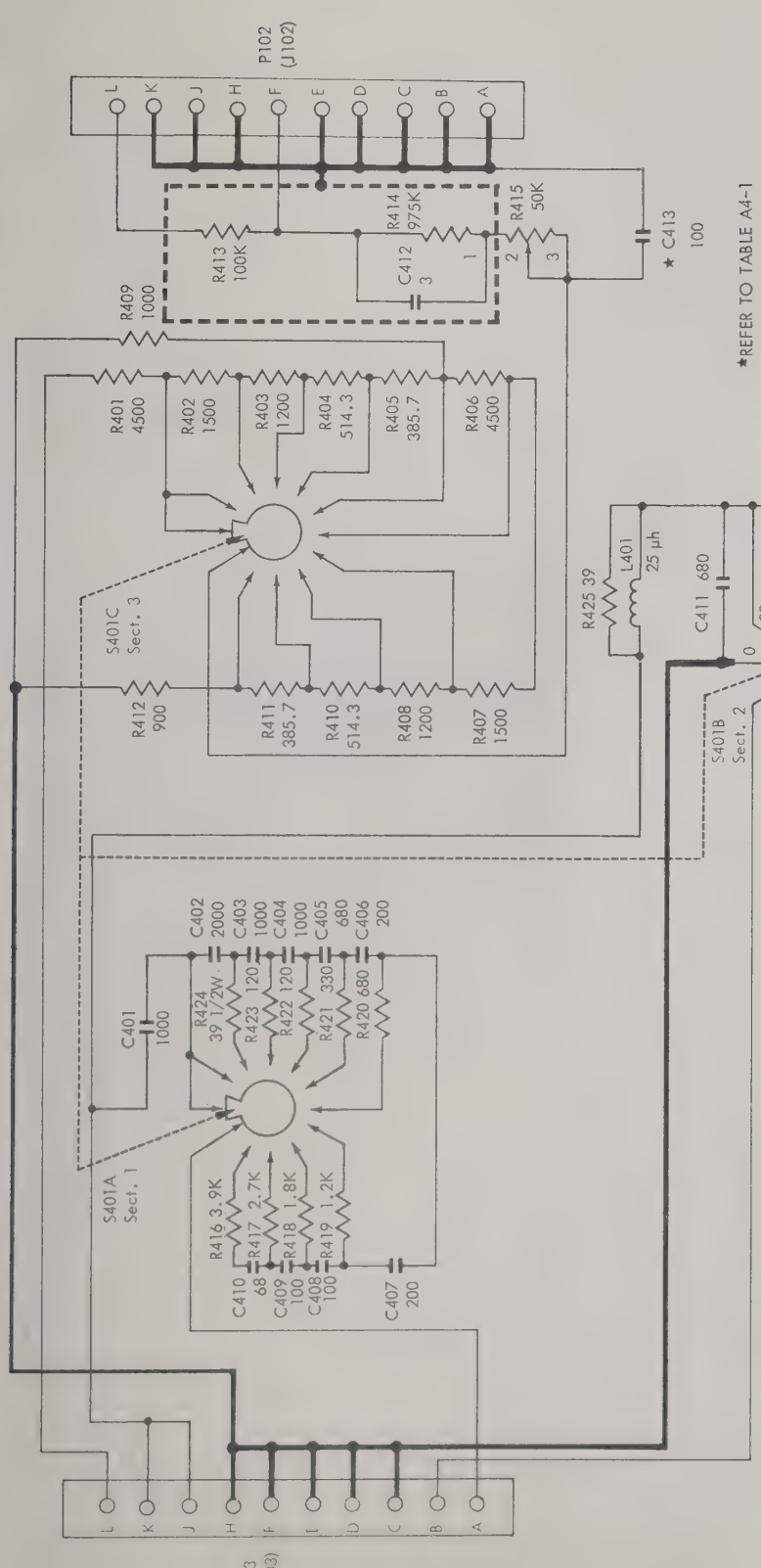
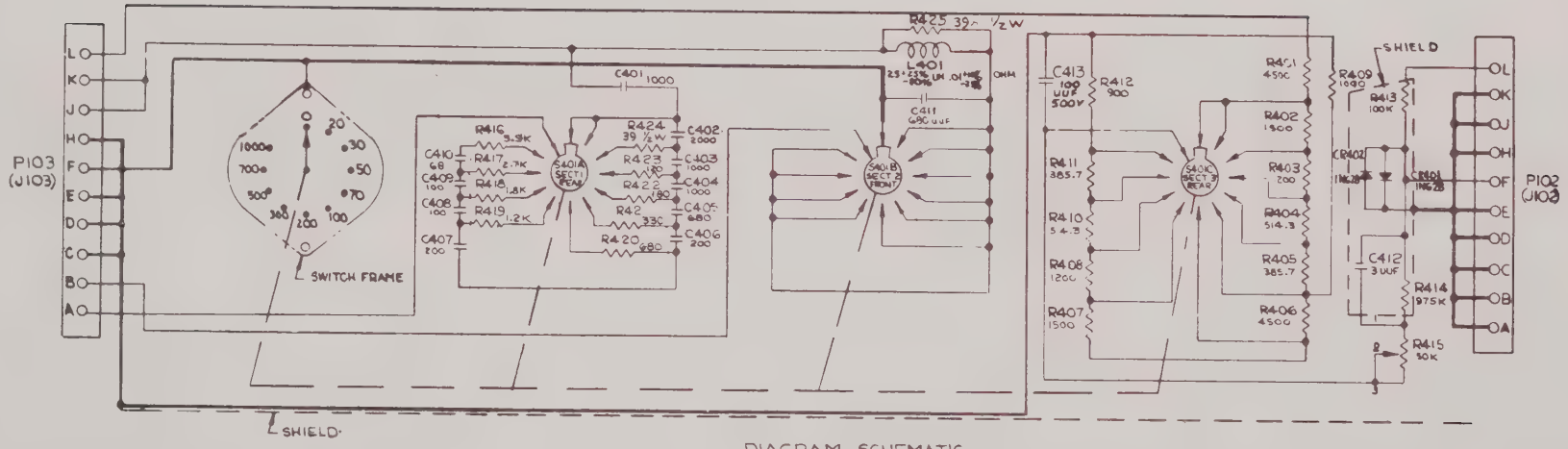


Figure A4-7. Schematic Diagram: Amplifier Function Plug-In, Model 112A-A (Variable Gain)



DIAGRAM, SCHEMATIC

7. CAUTION, USE CARE WHEN TIGHTENING SCREWS.
6. DISPOSE OF EXISTING LOCKWASHER & SECURE MOUNTING NUT OF ITEM 003 WITH ITEM 031.
5. ALL CAPACITORS 600 VOLTS.
4. ALL CAPACITANCES IN MICRO-MICROFARADS.
3. ALL RESISTORS 1/4W, ±5%.
2. ALL RESISTANCES IN OHMS.
1. INSTALL PER 9910014 & COAT WITH CLEAR LACQUER T-L-58, APPROX. AS SHOWN.

NOTE: UNLESS OTHERWISE SPECIFIED

Figure A4-8. Schematic Diagram: Amplifier Function Plug-In, Model 112A-A (Variable Gain) (Dwg. No. 8079010T, Serial Nos. 1-1821 and above)

Technical Manual
Code No. 2X-62S-A+AO

MODEL 112A-A+AO

FUNCTION PLUG-IN

SERIAL NUMBER EFFECTIVITY:
2-0001 and above

*Supplement to Operating and Maintenance Instructions for Model 112A Wideband DC Amplifier (Code No. 2X-62).

1 OCTOBER 1964

INSTRUCTION MANUAL CHANGES

Change No. 1
1 October 1964

Code No. 2X-62S-A+AO

MODEL 112A-A+AO FUNCTION PLUG-IN

SERIAL NUMBER EFFECTIVITY: 2-0001 and above

CHANGES IN FIGURES:

Figure A+AO1-1, Page A+AO1-3. Add R426 between Pins H and L of P103.

COHU
ELECTRONICS, INC
KIN TEL DIVISION

Section I
GENERAL DESCRIPTION

1-1. GENERAL. The Model 112A-A+AO is functionally identical to the 112A-A Function Plug-In, except that the gain switch has a twelfth position marked "OP."

1-2. DIFFERENCE DATA.

The 112A-A+AO Function Plug-In is functionally identical to the 112A-A Function Plug-In with an additional OP position or to the 112A-AO Function Plug-In with an additional 0 position. The use of this plug-in is identical to that of the 112A-A for all positions except OP. The use of the OP position is identical to the use of the OP positions of the 112A-AO plug-in.

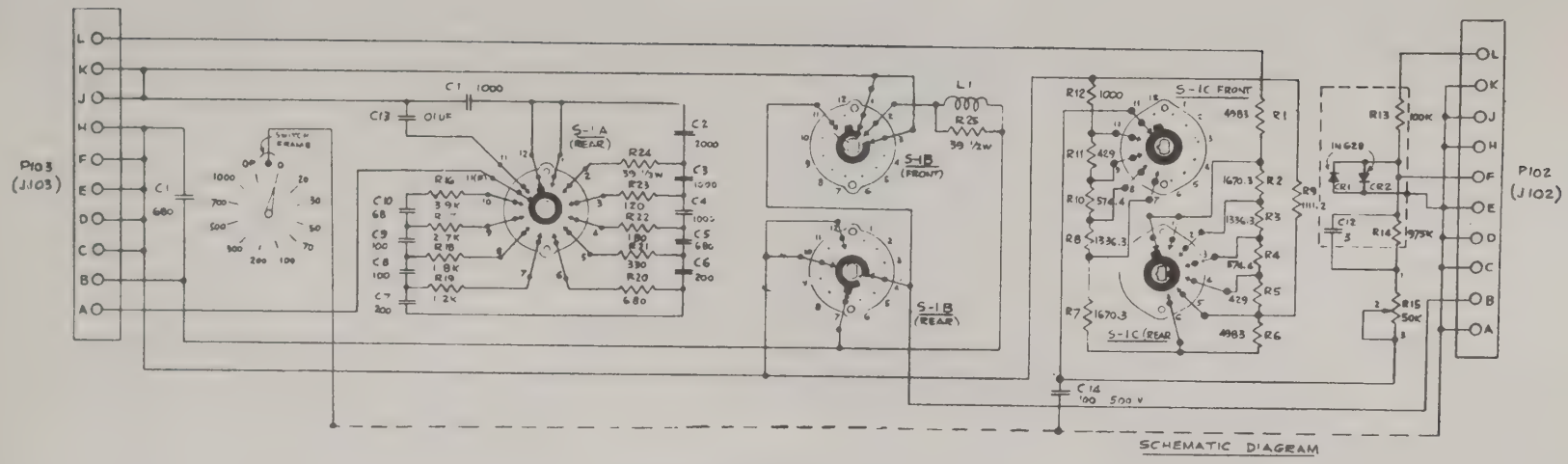
Electrical differences occur in the wiring of this plug-in because the gain switch has five poles rather than three and twelve positions rather than eleven positions. See Figure A+AO1-1 for the schematic diagram of this plug-in.

Table A+AO1-1. List of Replacement Parts for Model 112A-A+AO Function Plug-In

CIRCUIT REF.	DESCRIPTION	KIN TEL PART NO.
C401	CAPACITOR, CERAMIC DISC, 500V, .001 MF	0401046
C402	CAPACITOR, CERAMIC DISC, 500V, .002 MF	0401048
C403	CAPACITOR, CERAMIC DISC, 500V, .001 MF	0401046
C404	CAPACITOR, CERAMIC DISC, 500V, .001 MF	0401046
C405	CAPACITOR, CERAMIC DISC, 1000V, 680 PF	0401042
C406	CAPACITOR, CERAMIC DISC, 1000V, 200 PF	0401027
C407	CAPACITOR, CERAMIC DISC, 1000V, 200 PF	0401027
C408	CAPACITOR, CERAMIC DISC, 1000V, 100 PF	0401022
C409	CAPACITOR, CERAMIC DISC, 1000V, 100 PF	0401022
C410	CAPACITOR, CERAMIC DISC, 1000V, 68 PF	0401018
C411	CAPACITOR, CERAMIC DISC, 1000V, 680 PF	0401042
C412	CAPACITOR, CERAMIC, 500V, 3 PF, STACKPOLE	0406759-029
C413	CAPACITOR, CERAMIC DISC, 200V, .01 MF	0407316-007
C414	CAPACITOR, MOLDED SILVER MICA, CM-15, 100 PF	1010000-027
CR401	DIODE, 1N628	3510004

Table A+AO1-1. List of Replacement Parts for Model 112A-A+AO Function Plug-In (Contd)

CIRCUIT REF.	DESCRIPTION	KIN TEL PART NO.
CR402	DIODE, 1N628	3510004
L401	CHOKE, 25 μH, MOD. 112A PLUG-INS	6710011-001
R401	RESISTOR, PRECISION, 1/4W, .25%, 4983 OHMS	5210086-408
R402	RESISTOR, PRECISION, 1/4W, .25%, 1670.3 OHMS	5210086-406
R403	RESISTOR, PRECISION, 1/4W, .25%, 1336.3 OHMS	5210086-405
R404	RESISTOR, PRECISION, 1/4W, .25%, 572.4 OHMS	5210086-402
R405	RESISTOR, PRECISION, 1/4W, .25%, 429 OHMS	5210086-401
R406	RESISTOR, PRECISION, 1/4W, .25%, 4983 OHMS	5210086-407
R407	RESISTOR, PRECISION, 1/4W, .25%, 1670.3 OHMS	5210086-406
R408	RESISTOR, PRECISION, 1/4W, .25%, 1336.3 OHMS	5210086-405
R409	RESISTOR, PRECISION, 1/4W, .25%, 1111.2 OHMS	5210086-404
R410	RESISTOR, PRECISION, 1/4W, .25%, 572.4 OHMS	5210086-402
R411	RESISTOR, PRECISION, 1/4W, .25%, 429 OHMS	5210086-401
R412	RESISTOR, PRECISION, 1/4W, .25%, 1000 OHMS	5210086-403
R413	RESISTOR, FIXED FILM, 1/4W, .5%, 100K	5210068-003
R414	RESISTOR, FIXED FILM, 1/4W, .5%, 975K	5210068-005
R415	RESISTOR, VAR., COMPOSITION, MIN., 50K	5010181-004
R416	RESISTOR, 1/4W, 5%, 3900 OHMS	4045000-392
R417	RESISTOR, 1/4W, 5%, 2700 OHMS	4045000-272
R418	RESISTOR, 1/4W, 5%, 1800 OHMS	4045000-182
R419	RESISTOR, 1/4W, 5%, 1200 OHMS	4045000-122
R420	RESISTOR, 1/4W, 5%, 680 OHMS	4045000-681
R421	RESISTOR, 1/4W, 5%, 330 OHMS	4045000-331
R422	RESISTOR, 1/4W, 5%, 1800 OHMS	4045000-181
R423	RESISTOR, 1/4W, 5%, 120 OHMS	4045000-121
R424	RESISTOR, 1/2W, 5%, 39 OHMS	0310030-390
R425	RESISTOR, 1/2W, 5%, 39 OHMS	0310030-390
R426	RESISTOR, 1/8W, 1%, 57.2K	5210051-042
S401	SWITCH, ROTARY, 12 POSITION, 5 POLE	6210108-001



7. REF DESIGNATIONS ARE ABBREVIATED PREFIX ALL WITH 4, IE., R9 SHOULD READ R409, C14 BECOMES C414, ETC.

6. SOLDER PER MIL-S-6872.

5. DISPOSE OF LOCK-WASHER SUPPLIED WITH ITEM 002 AND SECURE MTG. NUT WITH SEALANT (KEEPING ITEM 001 FREE OF SAME).

4. NO "STOPS" ON SWITCH.

3. SWITCH WAFERS SHOWN LOOKING FROM KNOB END OF SWITCH.

2. ALL RESISTOR VALUES IN OHMS RATING 1/4W.

1. ALL CAPACITOR VALUES IN μμF AT 600V.

NOTES: UNLESS OTHERWISE SPECIFIED

Figure A+AO1-1. Schematic Diagram: Amplifier Function Plug-In, Model 112A-A+AO (Dwg. No. 8091002A, Serial Nos. 2-0001 and above)

Technical Manual
Code No. 2PX-62S-AO*

OPERATING AND MAINTENANCE INSTRUCTIONS FOR MODEL 112A-AO FUNCTION PLUG-IN (OPERATIONAL VARIABLE GAIN)

*Supplement to Operating and Maintenance Instructions for Model 112A Wideband DC Amplifier (Code No. 2X-62)

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1 OCTOBER 1961

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Section I
GENERAL DESCRIPTION

1-1 INTRODUCTION

1-2. For basic general descriptions of KIN TEL Model 112A Series Function Plug-Ins, refer to the green section (Code No. 2X-62S-A) of this volume.

1-3 IDENTIFICATION

1-4. The KIN TEL Model 112A-AO Function Plug-In is the "operational" version of the Model 112A-A Variable Gain Plug-In. In addition to the eleven gain ranges of the 112A-A, the 112A-AO has an operational position; i. e, when the control is in the "0" position, the user may connect external operational networks to the amplifier.

1-5 PHYSICAL DETAILS

1-6. Basic details of the physical configuration of the Model 112A-AO are the same as for the 112A-A. (Refer to paragraphs 1-6 through 1-9 in the green section.)

1-7 OPERATING CHARACTERISTICS

1-8. Operating characteristics of the Model 112A-AO are the same as for the Model 112A-A, which may be referred to in the green section.

1-9 OUTLINES AND DIMENSIONS

1-10. Dimensions and outlines of the Model 112A Wideband DC Amplifier with plug-in installed are given in Figure 1-9 of the amplifier manual (Code No. 2X-62). Dimensions and outlines of the Model 112A-AO Function Plug-In are the same as shown for the Model 112A-A (Figure A1-2 in the green section).

1-11 SPECIFICATIONS

1-12. Specifications for the Model 112A/AO Wideband DC Amplifier (Model 112A-AO Plug-In installed) are the same as those listed in Table A1-2 of the green section in all gain positions other than the "0" position. For operational use, the performance will necessarily be largely determined by the nature of the external operational network installed.

1-13. Operational characteristics of the Model 112A/AO will be found in Sections II and III of this publication.

Section II
OPERATION

2-1 GENERAL

2-2. For other than operational use, instructions provided in the green section of this volume will suffice for unpacking, installing, connecting and operating the Model 112A amplifier equipped with the Model 112A-AO plug-in.

2-3 OPERATIONAL USE

2-4. Table AO2-1 provides some basic examples of operational use, tabulated according to input and feedback impedances. The letter p represents a small signal change with respect to time:

$$p = \frac{de}{dt}$$, and the reciprocal

of p is the integral of a small change with respect to time:

$$\frac{1}{p} = \int dt.$$

2-5. The impedance of Z_o in Table AO2-1 must include sufficient capacity to corner at or below 50 kc. The impedance of β must then be such that it is capable of driving Z_o well beyond 50 kc. Many types of operation can be achieved by using different values of Z_i and Z_o with appropriate dividers in the output circuit.

2-6 INSTALLING OPERATIONAL NETWORKS

2-7. Operational networks may be connected to the amplifier connector in the rack module, or---if the amplifier is housed in a single-unit housing such as the Model 195 Cabinet---to the cable connectors on the housing. Figure AO2-1 illustrates the connection of operational components to the amplifier connector in the Model 190B Rack Module.

2-8. Note that all leads should be shielded. Use special care in shielding the point where Z_o, Z_i, and the amplifier input are tied together. To

Table AO2-1. Impedances and Characteristics for Typical Operational Use

Z_i	Z_o	TRANSFER CHARACTERISTIC	USE
R_i	R_o	$-\frac{R_o}{R_i}$	1. Scale Change (amplification) 2. Sign Change (phase inversion) 3. Impedance Transformer
R_i	C_o	$\frac{-1}{R_i C_o p}$	Integrator
R_i	C_o in parallel with R_o	$-\frac{R_o}{R_i} \frac{1}{1 + R_o C_o p}$	Low pass filter $F_{cut\text{-}off} = \frac{1}{2 R_o C_o}$

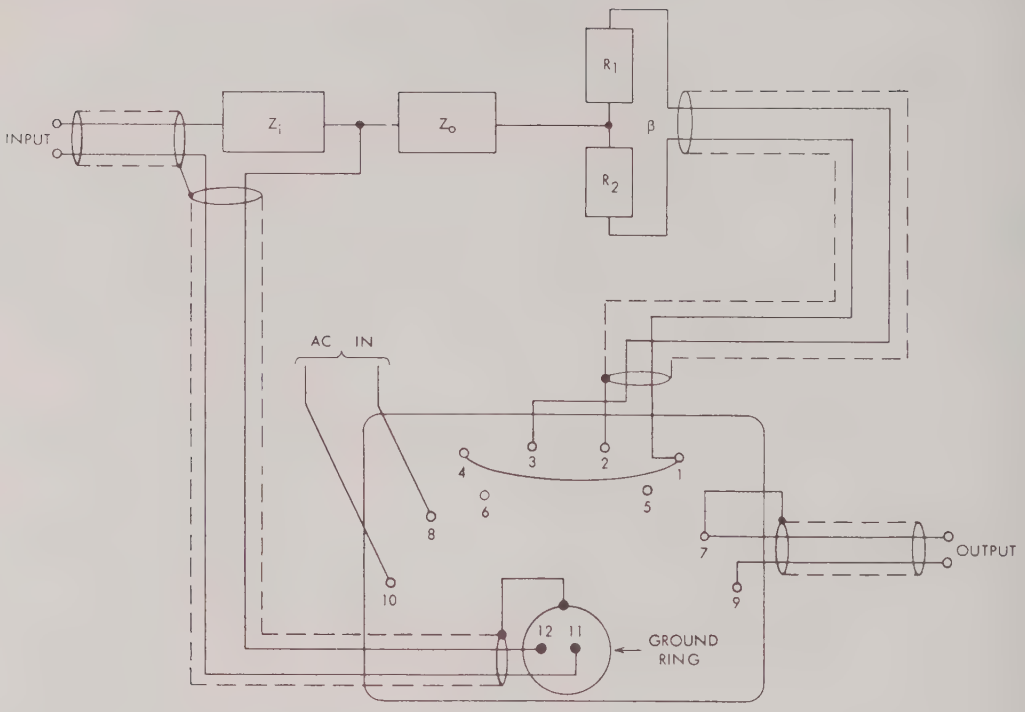

Figure AO2-1. Operational Component Connections to Amplifier Connector

prevent ground loop problems, the shields should be grounded at one end only. Leads to the constants should be as short as possible to minimize the addition of capacity, especially at the junction of Z_o, Z_i, and the amplifier input.

2-9. For additional information on operational networks to be used with the Model 112A/AO Wideband DC Amplifier, refer to the pink section of this volume (Code No. 2PX-62S-O) which covers the construction of operational networks in the Model 112A-O (Operational) Function Plug-In.

Section III
TEST PROCEDURES

3-1 GENERAL

3-2. Significant tests of the Model 112A-AO Function Plug-In can be made only when installed in the Model 112A Wideband DC Amplifier. Consequently, these tests are significant of amplifier performance as well as plug-in acceptability.

3-3. Information given in Section III of the manual supplement for the Model 112A-A (green portion of this volume) will be applicable to the Model 112A-AO as well, with the following exceptions:

a. In Figure A3-3, the readings tabulated for the "0" gain switch setting will not apply; these readings will depend upon the operational network involved.

b. Where text refers to "all gain ranges" or "each gain setting," reference is not intended to include the "0" position.

Section IV
MAINTENANCE

4-1 GENERAL

4-2. The general instructions for maintenance as given in paragraphs 4-1 through 4-16 of the manual supplement (green section of this volume) for the 112A-A are also applicable to the Model 112A-AO.

4-3. PARTS IDENTIFICATION

4-4. Figure AO4-1 illustrates the input etched board assembly of the Model 112A-AO. The output etched board assembly is shown in Figure AO4-2.

4-5. Table AO4-1 lists the replacement parts of the Model 112A-AO Function Plug-In. Manufacturers of specific components are designated by code, and these tabulations may be decoded by reference to the list of Manufacturers' Code Designations (Table AO4-2).

4-6. Figure AO4-3 schematically illustrates the circuitry of the Model 112A-AO. Note that P102 and P103 in Figure AO4-3 mate with J102 and J103, respectively, in Figure 4-32 of the amplifier manual (2X-62).

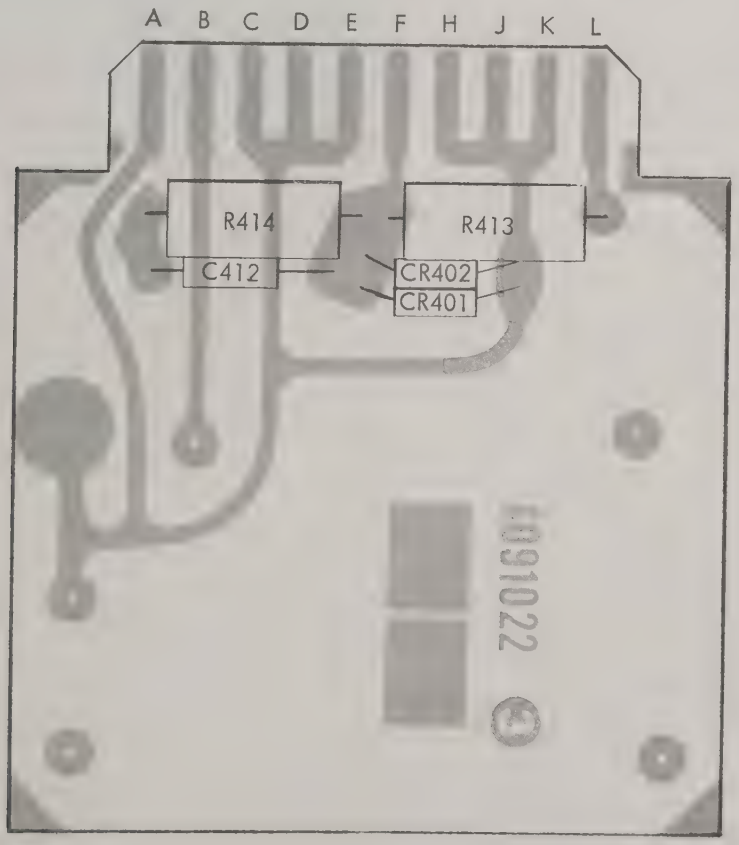

Figure AO4-1. Input Etched Board Assembly, Shown from Etched Side

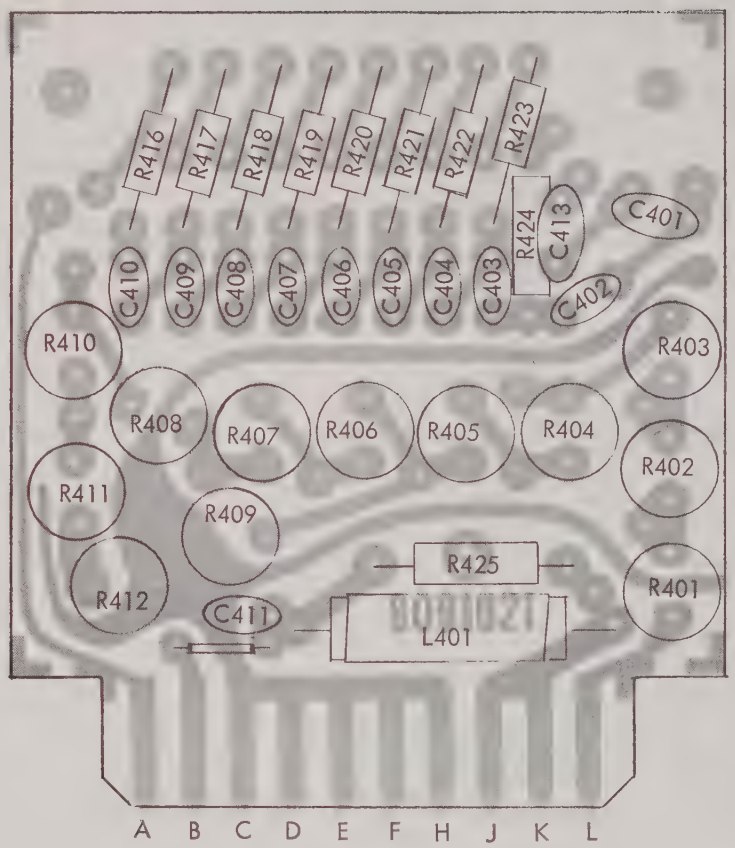

Figure AO4-2. Output Etched Board Assembly, Shown from Etched Side

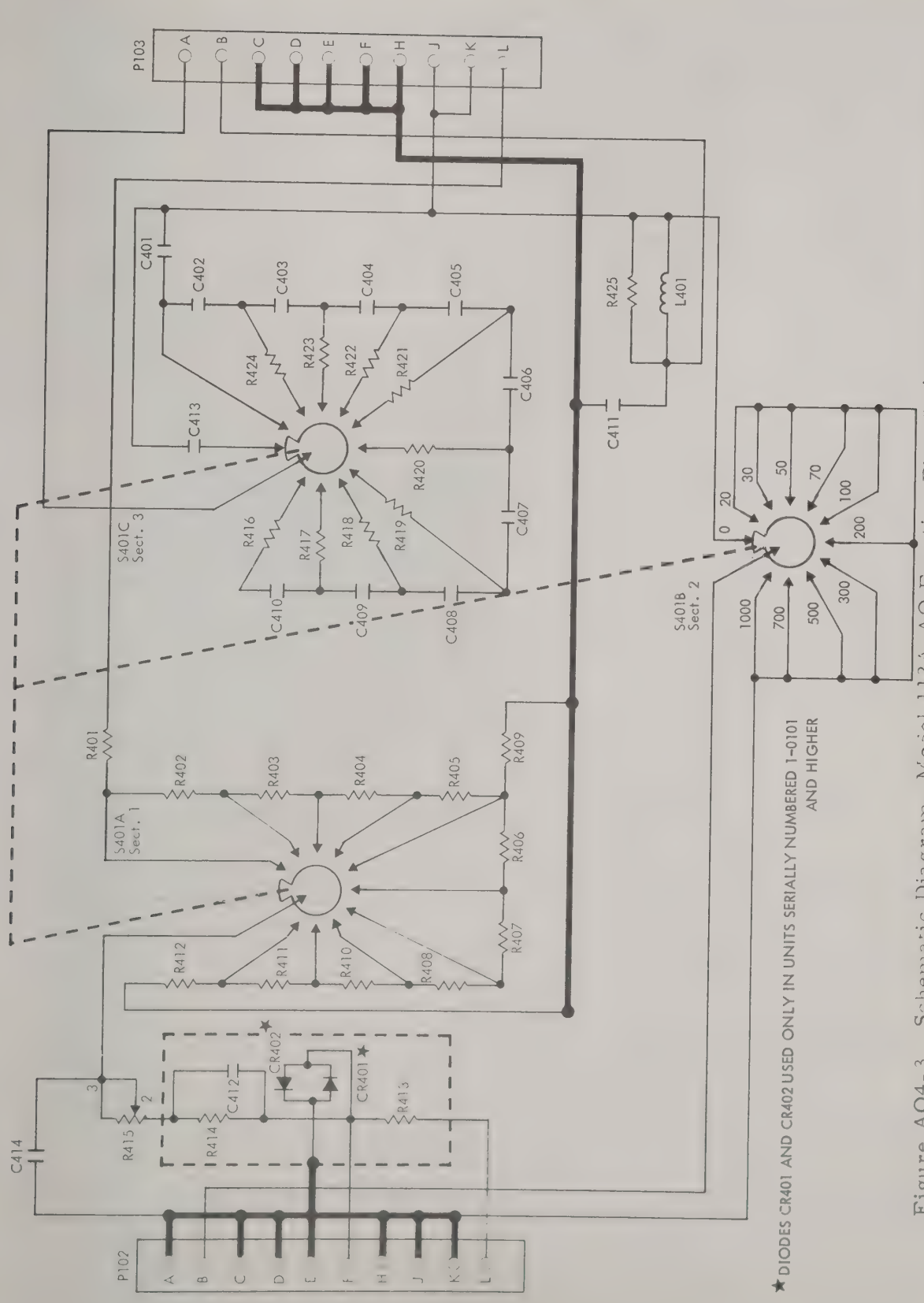

Figure AO4-3. Schematic Diagram, Model 112A-AO Function Plug-In (Operational Variable Gain)

Table AO4-1. List of Replacement Parts, Model 112A-AO Function Plug-In

CIRCUIT SYMBOL	DESCRIPTION	# MFR.	KIN TEL PART NO.
C401	CAPACITOR, FIXED, CERAMIC DIELECTRIC, .001 µf, 600V DC	EIA	0401046
C402	CAPACITOR, FIXED, CERAMIC DIELECTRIC, .002 µf, 600V DC	EIA	0401048
C403	CAPACITOR, FIXED, CERAMIC DIELECTRIC, .001 µf, 600V DC	EIA	0401046
C404	CAPACITOR, FIXED, CERAMIC DIELECTRIC, .001 µf, 600V DC	EIA	0401046
C405	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 680 pf, 600V DC	EIA	0401042
C406	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 200 pf, 600V DC	EIA	0401027
C407	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 200 pf, 600V DC	EIA	0401027
C408	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 100 pf, 600V DC	EIA	0401022
C409	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 100 pf, 600V DC	EIA	0401022
C410	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 68 pf, 600V DC	EIA	0401018
C411	CAPACITOR, FIXED, CERAMIC DIELECTRIC, 680 pf, 600V DC	EIA	0401042
C412	CAPACITOR, FIXED, COMPOSITION, 3 pf, 500V DC, 5%	STP	0406759-029
C413	CAPACITOR, FIXED, CERAMIC DIELECTRIC, .01 µf, 600V DC	EIA	0401056
☆ C414	CAPACITOR, FIXED, MOLDED MICA, 100 pf, 500V DC	ARC	1010000-027
★ CR401	SEMICONDUCTOR DEVICE, DIODE, Silicon junction, Type 1N628	HUG	3510004

Table AO4-1. List of Replacement Parts, Model 112A-AO Function Plug-In (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR.	KIN TEL PART NO.
★ CR402	SEMICONDUCTOR DEVICE, DIODE, Silicon junction, Type 1N628	HUG	3510004
L401	COIL, CHOKE, 25 μh (+25%, -10%), 0.1Ω, (+10%, -25%)	EWC	6710011-001
R401	RESISTOR, FIXED, WIRE-WOUND, 4983Ω, 1/4W, 20 ppm/°C	KT	5210086-407
R402	RESISTOR, FIXED, WIRE-WOUND, 1670.3Ω, 1/4W, 20 ppm/°C	KT	5210086-406
R403	RESISTOR, FIXED, WIRE-WOUND, 1336.3Ω, 1/4W, 20 ppm/°C	KT	5210086-405
R404	RESISTOR, FIXED, WIRE-WOUND, 572.4Ω, 1/4W, 20 ppm/°C	KT	5210086-402
R405	RESISTOR, FIXED, WIRE-WOUND, 429Ω, 1/4W, 20 ppm/°C	KT	5210086-401
R406	RESISTOR, FIXED, WIRE-WOUND, 4983Ω, 1/4W, 20 ppm/°C	KT	5210086-407
R407	RESISTOR, FIXED, WIRE-WOUND, 1670.3Ω, 1/4W, 20 ppm/°C	KT	5210086-406
R408	RESISTOR, FIXED, WIRE-WOUND, 1336.3Ω, 1/4W, 20 ppm/°C	KT	5210086-405
R409	RESISTOR, FIXED, WIRE-WOUND, 1111.2Ω, 1/4W, 20 ppm/°C	KT	5210086-404
R410	RESISTOR, FIXED, WIRE-WOUND, 572.4Ω, 1/4W, 20 ppm/°C	KT	5210086-402
R411	RESISTOR, FIXED, WIRE-WOUND, 429Ω, 1/4W, 20 ppm/°C	KT	5210086-401
R412	RESISTOR, FIXED, WIRE-WOUND, 1000Ω, 1/4W, 20 ppm/°C	KT	5210086-403
R413	RESISTOR, FIXED, FILM, High Stability, 100Ω, 1/4W, 0.5%	AB	5210068-003

Table AO4-1. List of Replacement Parts, Model 112A-AO Function Plug-In (Contd)

CIRCUIT SYMBOL	DESCRIPTION	# MFR.	KIN TEL PART NO.
R414	RESISTOR, FIXED, FILM, High Stability, 975KΩ, 1/4W, 0.5%	AB	5210068-005
R415	RESISTOR, VARIABLE, COMPOSITION, miniature, 50KΩ, 1/2W, 10%	AB	5010181-004
R416	RESISTOR, FIXED, COMPOSITION, 3.9KΩ, 1/4W, 5%	AB	4045000-392
R417	RESISTOR, FIXED, COMPOSITION, 2.7KΩ, 1/4W, 5%	AB	4045000-272
R418	RESISTOR, FIXED, COMPOSITION, 1.8KΩ, 1/4W, 5%	AB	4045000-182
R419	RESISTOR, FIXED, COMPOSITION, 1.2KΩ, 1/4W, 5%	AB	4045000-122
R420	RESISTOR, FIXED, COMPOSITION, 680Ω, 1/4W, 5%	AB	4045000-681
R421	RESISTOR, FIXED, COMPOSITION, 330Ω, 1/4W, 5%	AB	4045000-331
R422	RESISTOR, FIXED, COMPOSITION, 180Ω, 1/4W, 5%	AB	4045000-181
R423	RESISTOR, FIXED, COMPOSITION, 120Ω, 1/4W, 5%	AB	4045000-121
R424	RESISTOR, FIXED, COMPOSITION, 39Ω, 1/2W, 5%	AB	0310030-390
R425	RESISTOR, FIXED, COMPOSITION, 39Ω, 1/2W, 5%	AB	0310030-390
S401	SWITCH, ROTARY, 3P11T, 1A at 28V DC, 0.5A at 110V AC	OAK	6210039-001
	☆ NOT USED IN UNITS WITH SERIAL NUMBERS LOWER THAN 1-0076		
	★ NOT USED IN UNITS WITH SERIAL NUMBERS LOWER THAN 1-0101		

Table AO4-2. List of Manufacturers' Code Designations

CODE	MANUFACTURER	ADDRESS
AB	Allen-Bradley Co.	Milwaukee, Wis.
ARC	Arco Electronics, Inc.	New York, N. Y.
EIA	Any brand meeting EIA Standards	
EWC	Electrowinders Co., Inc.	Covina, Calif.
HUG	Hughes Semiconductor Division, Hughes Aircraft Co.	Newport Beach, Calif.
KT	Cohu Electronics, Inc., Kin Tel Division	San Diego, Calif.
OAK	Oak Manufacturing Co.	Chicago, Ill.
STP	Stackpole Carbon Co.	St. Marys, Pa.

Technical Manual
Code No. 2X-62S-B*

MODEL 112A-B FUNCTION PLUG-IN

*Supplement to Operating and Maintenance Instructions for Model 112A Wideband DC Amplifier (Code No. 2X-62)

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Section I
GENERAL DESCRIPTION

1-1 INTRODUCTION

1-2. The KIN TEL Model 112A-B Function Plug-In is specifically designed for insertion into, and to be used with, the KIN TEL Model 112A Wideband DC Amplifier.

1-3. When used, a function plug-in is physically and electronically a component assembly of the particular Model 112A amplifier in which it is installed. However, the diversity of these plug-in units is such that each requires specific instruction manual coverage for operation and maintenance, and certain differences in operational theory exist among the various units. Since operation and maintenance have been previously covered in the green and pink pages of this volume, only the operational theory difference will be described.

1-4 IDENTIFICATION

1-5. The KIN TEL Model 112A-B Function Plug-In (see Figure B1-1) -- when installed in a Model 112A amplifier -- provides, for that amplifier, an overall circuit configuration representing a single gain selection of "+1."

1-6 PHYSICAL DETAILS

1-7. The KIN TEL Model 112A-B is a plug-in unit with a high-impact styrene cover. It is mounted on a finished panel which -- when installed for use -- becomes the lower half of the front panel of the KIN TEL Model 112A amplifier into which it is inserted. The front panel incorporates a handle which subsequently becomes the handle of the amplifier, and an adjustable pawl-latch which becomes the amplifier-to-housing lock.

1-8. An extremely neat and permanent cardholder, mounted on the front panel (see Figure O1-1 in the pink section of this manual), serves to retain the data card provided to permit identification of the plug-in function.

1-9 OUTLINES AND DIMENSIONS

1-10. Outlines and dimensions of the Model 112A-B are substantially the same as those shown in Figure A1-2 of the green section of this publication. The single notable difference is the cardholder in place of the switch knob.

1-11 SPECIFICATIONS

1-12. The electronic specifications of the Model 112A-B Function Plug-In are listed in Table B1-1.

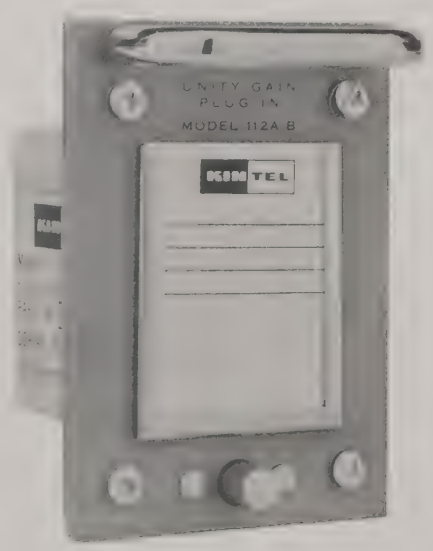


Figure B1-1. KIN TEL Model 112A-B Function Plug-In Unit

Table B1-1. Specifications of the KIN TEL Model 112A DC Amplifier with the Model 112A-B Plus-One Plug-In Unit

GAIN (Non-inverting) . . . . . +1

GAIN ACCURACY, at DC. . . . . ±0.001%
at 2 KC. . . . ±0.1%

GAIN STABILITY, at DC. . . . . ±0.001%
at 2 KC. . . . ±0.1%

LINEARITY, at DC. . . . . ±0.001%
at 2 KC. . . . . ±0.1%

INPUT IMPEDANCE, at DC . . . 10,000 Megohms +100 μμf
at 2 KC . . 1000 Megohms +100 μμf

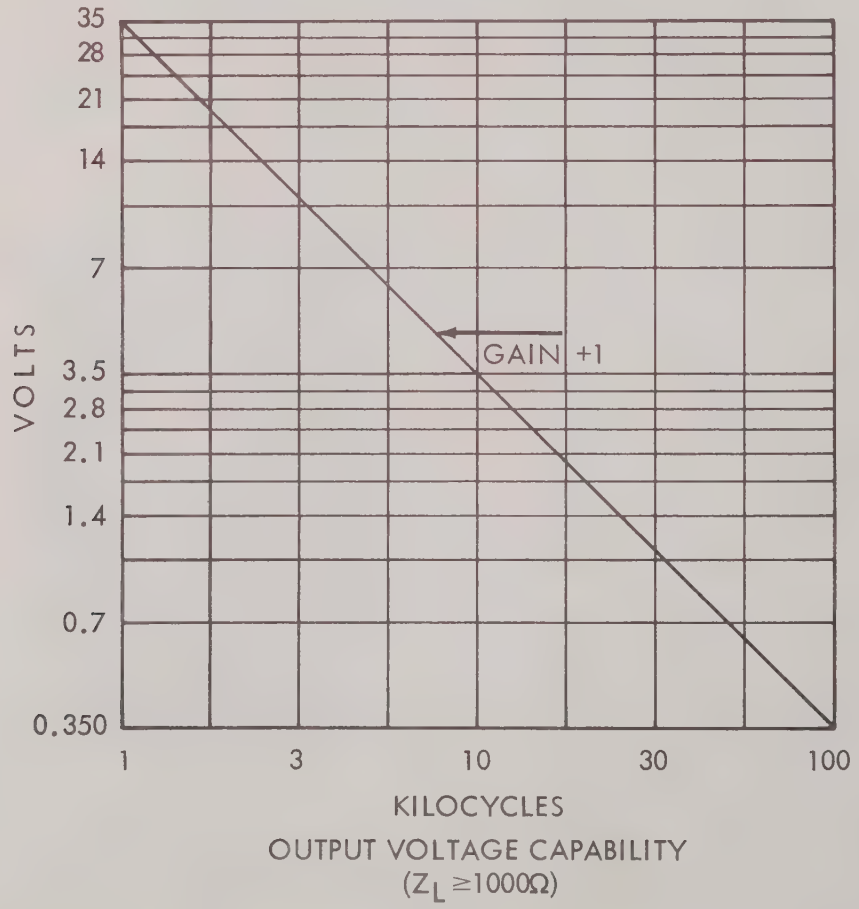
BANDWIDTH . . . . . 100 KC, ±3 db (See Output Voltage Capability Graph)

SIGNAL SOURCE IMPEDANCE. . Not restricted

OUTPUT CAPABILITIES. . . . . See Output Voltage Capability Graph

OUTPUT IMPEDANCE . . . . . Same as with 112A-A Plug-In

OUTPUT CABLE CAPACITY. . . Up to 0.1 μf



OUTPUT VOLTAGE CAPABILITY
($Z_L \geq 1000\Omega$)

Section II
INSTALLATION AND OPERATION

2-1 UNPACKING AND INSTALLATION

2-2. Unpacking and installation procedures for the Model 112A-B are similar to those listed for the Model 112A-A, and those of the Model 112A-O, in the green and pink pages of this volume.

2-3 OPERATION

2-4. Operation of the KIN TEL Model 112A Wideband DC Amplifier with the Model 112A-B Function Plug-In installed is simple and straightforward. Simply insert the function plug-in into the amplifier, secure, and insert the Model 112A amplifier into its housing. It is now ready for operation.

Section III
THEORY OF OPERATION

3-1 GENERAL

3-2. Essentially, the KIN TEL Model 112A/B Plus-One Wideband DC Amplifier may be compared to an impedance matching transformer which transfers the source voltage from one point to another in a data recording system without conditioning the signal in any way. In other words, the use of a plus-one 112A/B amplifier overcomes the difficulty of loading error. The amplifier provides an extremely high input and a very low output impedance.

3-3. The Model 112A-B Plus-One Function Plug-In permits the Model 112A amplifier to function as an extremely reliable cathode-follower whose input/output voltage ratio is, to all intents and purposes, unity ±0.001%.

3-4. A cathode follower is basically an amplifier in which inverse feedback is obtained by means of an unbypassed cathode resistor. The output voltage appears across this resistor. The cathode follower has a high input impedance and a very low output impedance, and for this reason is often described as an impedance transformer. Its voltage gain is always less than unity, but generally, the output power is at a much higher level than the power carried by the input signal.

3-5. One very important use of the cathode follower is found in highly complex electronic data systems where a signal must be transmitted along a transmission line for a considerable distance (often as much as 100 feet or more). A transmission line normally represents a low impedance, and thus the low impedance output of the cathode follower is ideally suited for supplying maximum power to such a line.

3-6. The conventional cathode follower is a single-stage single-loop inverse-feedback circuit in which the output voltage is taken across the cathode resistor. There is no cathode bypass capacitor. The plate of the tube is usually connected directly to B+.

3-7. When a positive signal voltage is applied to the grid, the plate current increases, and the voltage drop across the cathode resistor increases, i.e., the plate current flows in the cathode resistor. Similarly, a negative signal voltage reduces the plate current and the voltage developed across the cathode resistor decreases. Thus the voltage across the cathode resistor "follows" the grid voltage.

3-8. Because of the particular action just explained, the output voltage is in phase with the input signal at all times.

3-9. Since the cathode-coupled circuit is highly degenerative, it is largely free from variations in gain and terminal impedance due to changes in tube parameters, or applied voltages, and its transfer characteristic tends to be highly linear.

3-10 DETAILED OPERATION

3-11. The input impedance of the Model 112A/B amplifier is 10,000 Megohms shunted by 100 μμf at DC, decreasing to 1,000 Megohms at 2 KC. Output impedance is less than one ohm. If we assume, then, the

112A/B amplifier connected between a one megohm transducer and a 10,000 ohm load, the transfer error (if it may be termed an error) caused by the 112A/B amplifier input impedance (10,000 Megohms) and the amplifier output impedance (one ohm) is only one part in 10^{11}, which, to all intents and purposes, is practically incalculable.

3-12. Actually, what was done in the above example was to connect a 10,000 ohm load to a one megohm source and preserved a system accuracy of 0.02%.

3-13. Figure B3-1 is a schematic diagram of the Plus-One plug-in module. Figure B3-2 illustrates network construction and pin connections when the Plus-One network is inserted into the Model 112A amplifier.

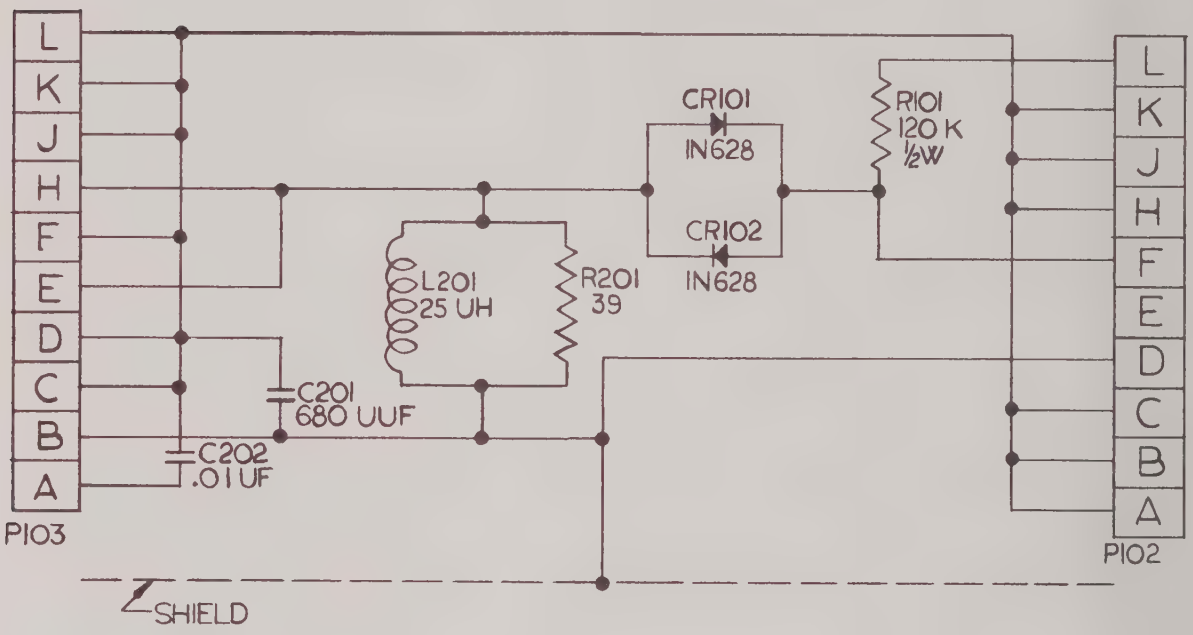


Figure B3-1. Schematic Diagram: Model 112A-B Plus-One Plug-In Module

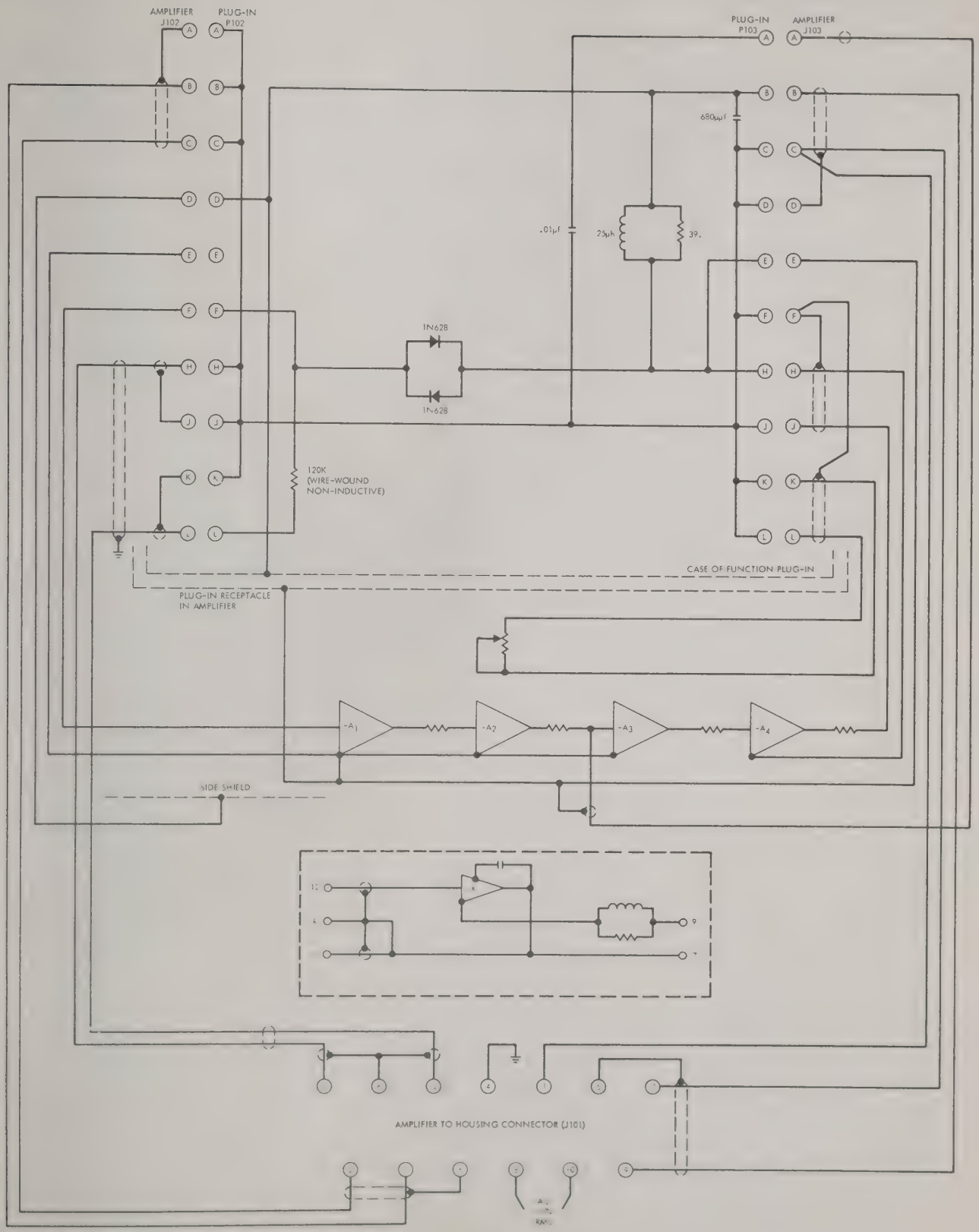


Figure B3-2. Typical +1 Network Constructed in 112A-B Plug-In

Table B3-1. List of Replacement Parts

CIRCUIT SYMBOL	DESCRIPTION	# MFR.	KIN TEL PART NO.
C101	CAPACITOR, FIXED, MICA DIELECTRIC, 680 pf, 1000VDC	CLB	0401042
C102	CAPACITOR, FIXED, MICA DIELECTRIC, 0.01 μf, 1000VDC	CLB	0401056
CR101	SEMICONDUCTOR DEVICE, DIODE, Type 1N628	HUG	3510004
CR102	SEMICONDUCTOR DEVICE, DIODE, Type 1N628	HUG	3510004
L201	CHOKE, RF, 25 μh, 0.1Ω	EWC	6710011-001
R101	RESISTOR, FIXED, COMPOSITION, 120K, 1/2W, 5%	AB	0310030-124
R201	RESISTOR, FIXED, COMPOSITION, 39Ω, 1/2W, 5%	AB	0310030-390

Table B3-2. Manufacturers' Code Designations

CODE	MANUFACTURER	ADDRESS
AB	Allen-Bradley Co.	Milwaukee, Wisc.
CLB	Centralab Division, Globe-Union	Milwaukee, Wisc.
EWC	Electrowinders Co., Inc.	Covina, Calif.
HUG	Hughes Semiconductor Division, Hughes Aircraft Co.	Newport Beach, Calif.

Technical Manual
Code 2PX-62S-O*

MODEL 112A-O AMPLIFIER FUNCTION PLUG-IN (FOR OPERATIONAL NETWORK CONSTRUCTION)

*Supplement to Operating and Maintenance Instructions for Model 112A Wideband DC Amplifier (Code No. 2X-62)

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O1-1	15 August 1960
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Additional copies of this manual may be obtained for a nominal fee through any KIN TEL representative or by writing to

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Section I
GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. For basic general descriptions of KIN TEL Model 112A Series Function Plug-Ins, refer to the green section (pages coded 2X-62S-A) of this volume.

1-3. IDENTIFICATION

1-4. The KIN TEL Model 112A-O Function Plug-In is designed to provide (for users of the KIN TEL Model 112A Wideband DC Amplifier) the fundamentals (both mechanical and electrical) necessary to the field construction of an operational network for the Model 112A.

1-5. PHYSICAL DETAILS

1-6. The Model 112A-O (Figure O1-1) Operational Plug-In consists of two etched boards (One "Input" and one "Output"), a board-mounting chassis, a styrene cover, and a finished panel which -- when installed for use -- becomes the lower half of the front panel of the Model 112A amplifier into which it is inserted. The panel incorporates a handle which consequently becomes the handle of the amplifier, and an adjustable-pawl latch which becomes the amplifier-to-housing lock.

1-7. A cardboard mounted on the front panel serves to retain the data card provided to permit identification of the plug-in after the operational components have been installed.

1-8. OUTLINES AND DIMENSIONS

1-9. Outlines and dimensions of the Model 112A-O are substantially the same as those shown in Figure A1-2 of the green section. The notable difference is the appearance of the cardboard holder in place of the switch knob.

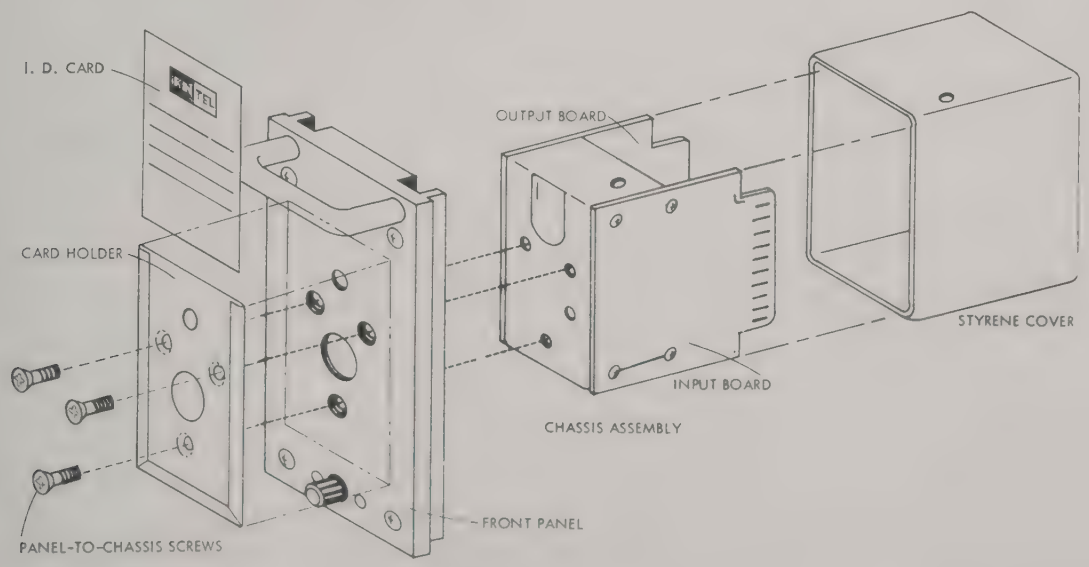


Figure O1-1. Model 112A-O Function Plug-In (Exploded View)

Section II
OPERATIONAL NETWORKS

2-1. BASIC PLUG-IN PROVISIONS

2-2. The Model 112A-O provides the optimum solution for a number of problems commonly associated with the construction of operational networks for DC amplifiers. The etched boards include a considerable quantity of pads for the installation of components and jumpers as required for a specific operational circuit.

2-3. The use of a number of plug-ins will permit rapid removal and replacement of several different operational networks without physically disturbing the position and connection of components -- a frequent cause of inaccuracies in such cases as involve "breadboard" or improperly mounted operational circuitry.

2-4. CONSTRUCTION NOTES

2-5. An important consideration in the construction of any operational circuit is the gain/phase response of the Model 112A amplifier with which it is to be used. More specifically, the amplifier, the network, and system conditions must be compatible.

2-6. Etched board design includes provisions for the modification -- over a limited range -- of the open-loop characteristics of the amplifier. A 25 μh choke (such as KIN TEL Part Number 6710011-001) shunted by a 39-ohm resistor connected in series with the output leads to capacitive loads will generally improve the stability margin and the overload recovery characteristics.

2-7. Loop gain will be controlled by a capacitance and series resistance in the internal loop; values of these components should be chosen for optimum performance under specific system conditions. The resistance will in any case consist of at least the 82-ohm unit connected to pin A of J103 in the amplifier itself; the capacitor will in all cases be added to the plug-in circuitry.

2-8. A generally safe initial choice for capacitance value is:

$$\frac{.02\ \mu f}{A}$$

where
A = amplifier gain after feedback.

However, optimum performance in most applications will be obtained with a capacitance smaller than that arrived at by the formula, which merely provides a starting point.

2-9. Integrators and other units not classed as simple amplifiers may be approached as though A were equal to a gain of one, unless experiment or analysis have provided a more precise figure.

2-10. Conversely, the resistance in the internal loop is usually optimized at a value higher than that indicated by the initial or "starting point" formula, which is:

$$R = 4A\,\Omega.$$

However, it can be seen that where A is equal to a gain of one, little would be gained by adding a 4-ohm resistor to the plug-in circuitry, since the 82-ohm resistor is already connected in the amplifier, and the

proportional change would be a negligible advantage.

2-11. As implicitly stated in preceding paragraphs, the only method of determining the best R/C values for a given network is one of actual trial in the circuit. It must be noted that all factors require close consideration when "bracketing in" on the final values; e.g., if capacitance is too small and resistance too large, noise will increase and the amplifier will lose frequency flatness and the ability to recover quickly from overloads.

2-12 REPRESENTATIVE NETWORKS

2-13. Figures O2-1 through O2-7 illustrate some typical operational networks which may be constructed in the Model 112A-O.

2-14. Note that Figure O2-5 is -- in effect -- an operational version of the Model 112A-A plug in. Modification of the 112A-A would be infinitely more practical than the complete construction of this network in the 112A-O. As indicated by the caption, this special plug-in is available from KIN TEL as the Model 112A-AO. It has been designed to permit use of the Model 112A amplifier as an improved replacement for the earlier Model 111BFO operational amplifier.

IMPORTANT

The 25 μh choke and 39Ω resistor described in paragraph 2-6 should be considered mandatory when designing almost any network in the 112A-O. This R-L combination allows the amplifier to perform with most capacitive networks connected to the amplifier output. Usually, time will be saved if these components are incorporated in original network design, and modified or removed only as indicated by performance. The choke should be rated at 25 μh +25%, -10% from 0 to 50 ma DC, and should have a DC resistance of 0.1Ω +10%, -25%. The choke available from Kin Tel under Part No. 6710011-001 meets these specifications.

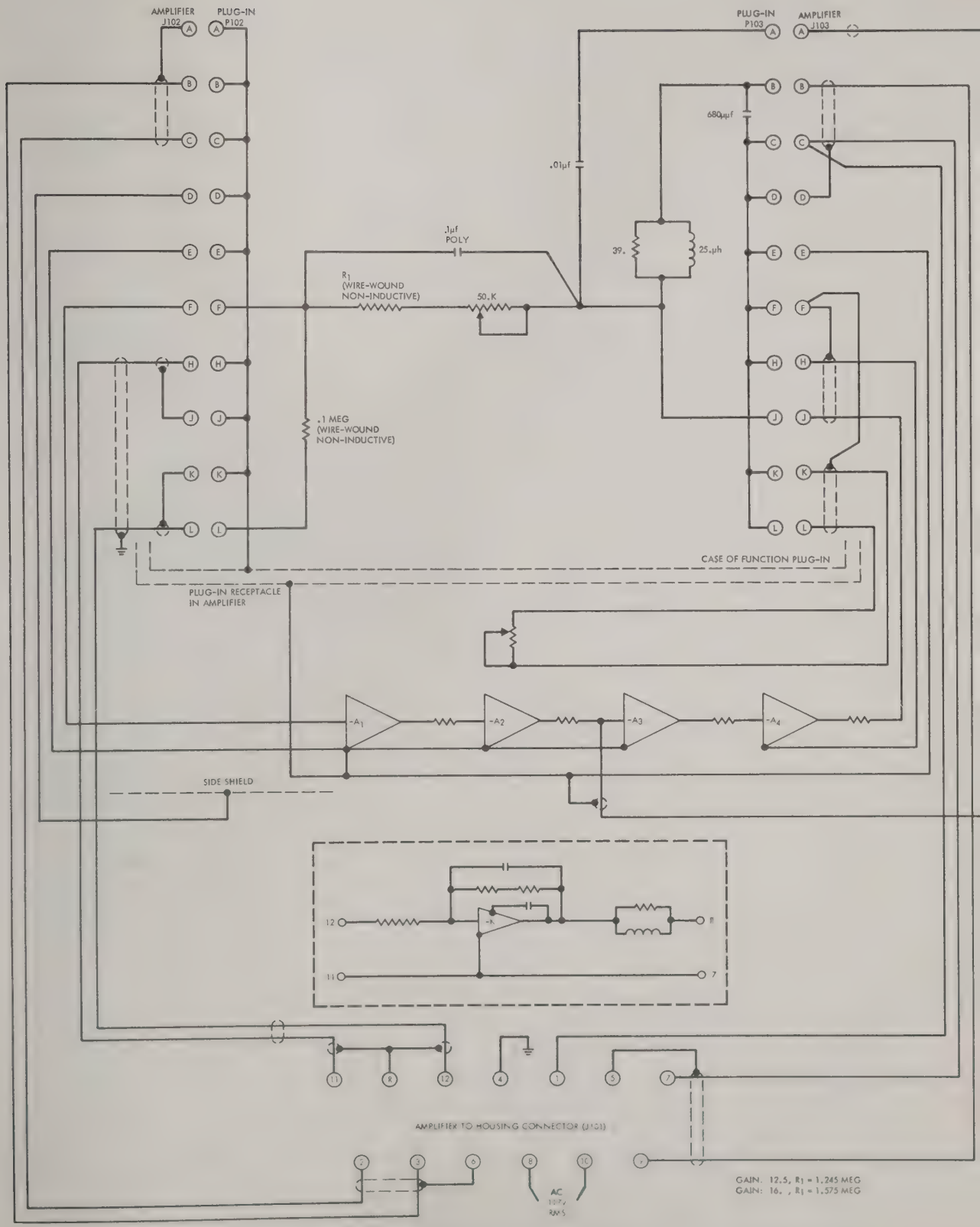


Figure O2-1. Typical Fixed-Gain Network Constructed in 112A-O

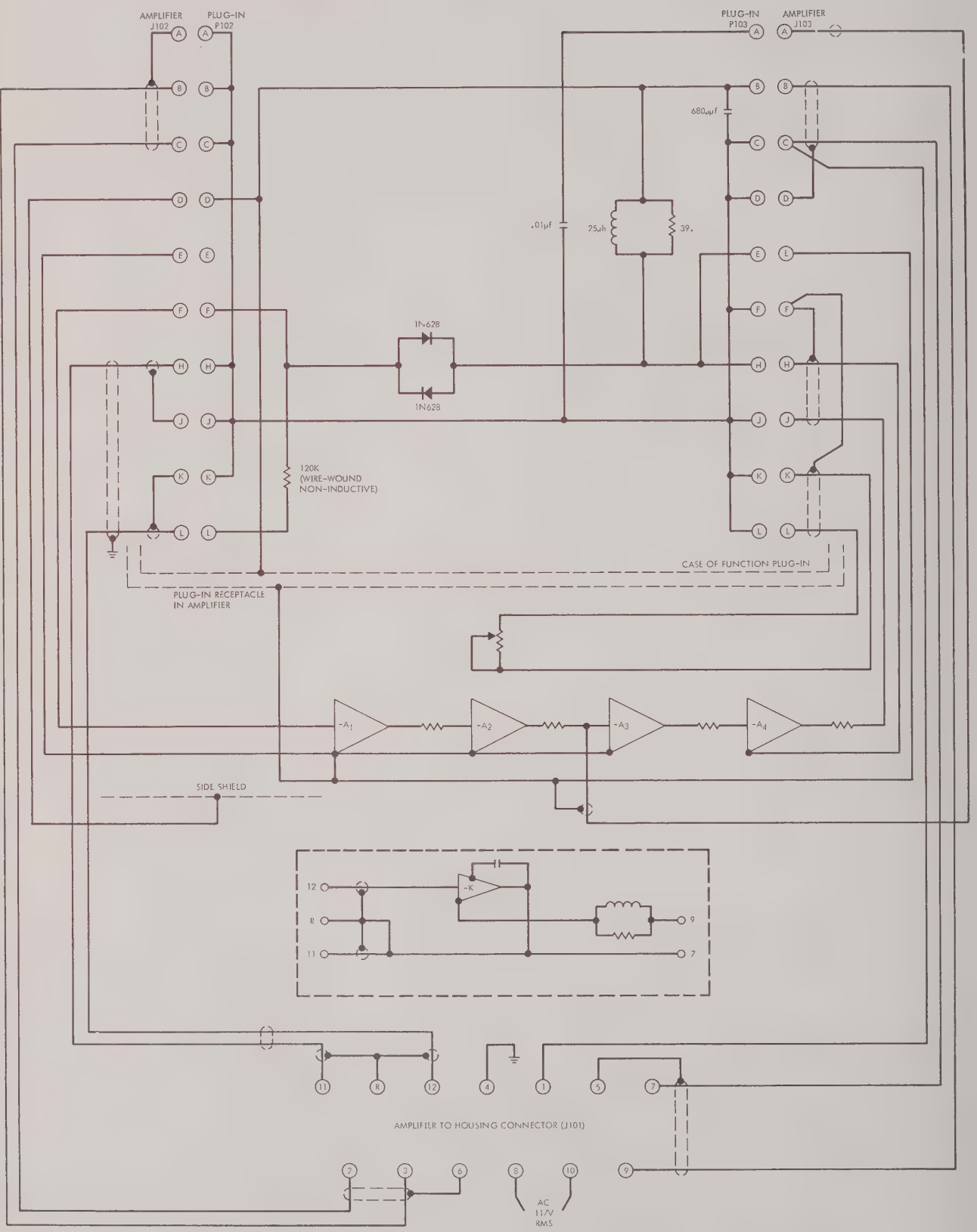


Figure O2-2. Typical +1 Network Constructed in 112A-O Plug-In

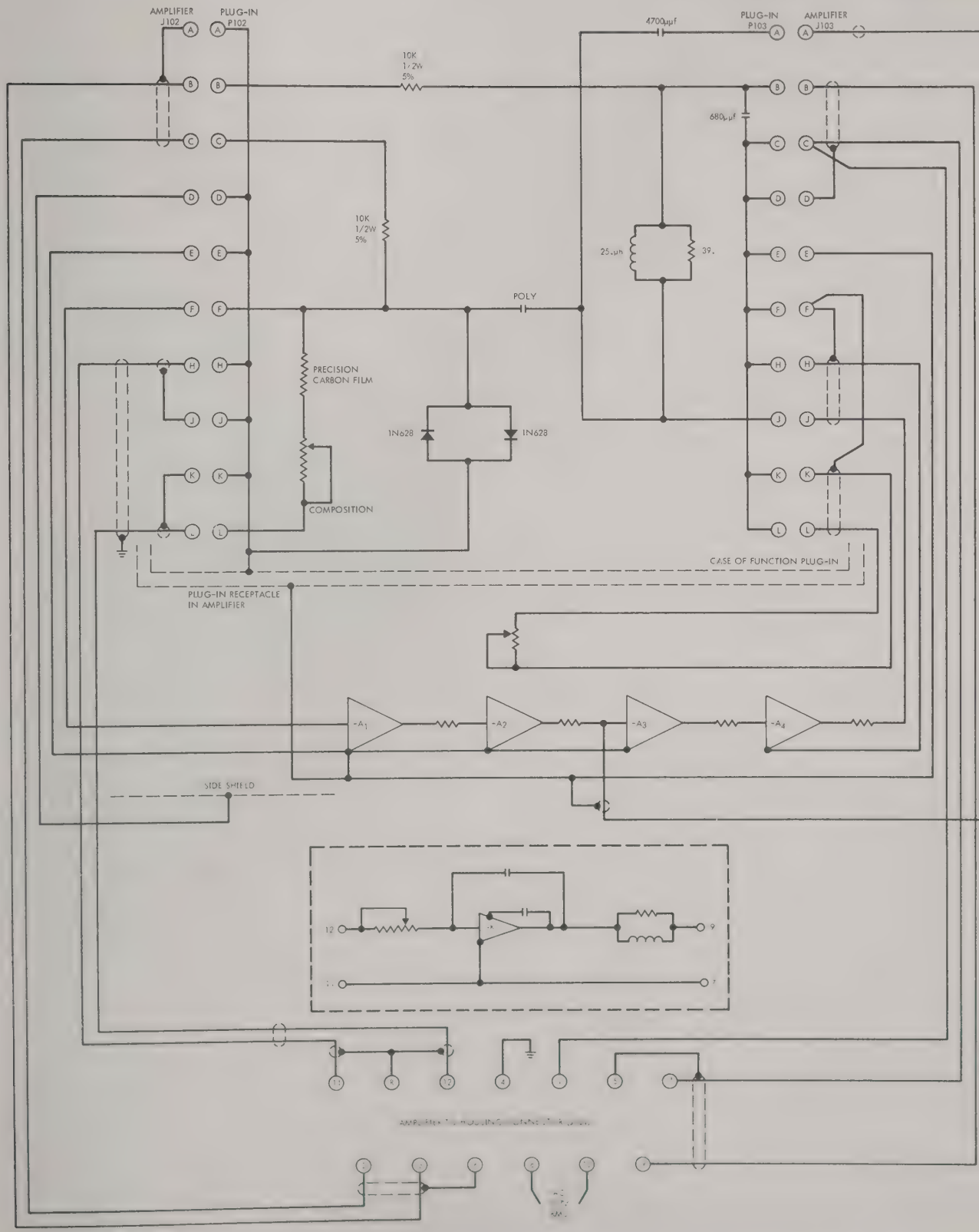


Figure O2-3. Typical Integrating Network Constructed in 112A-O Plug-In

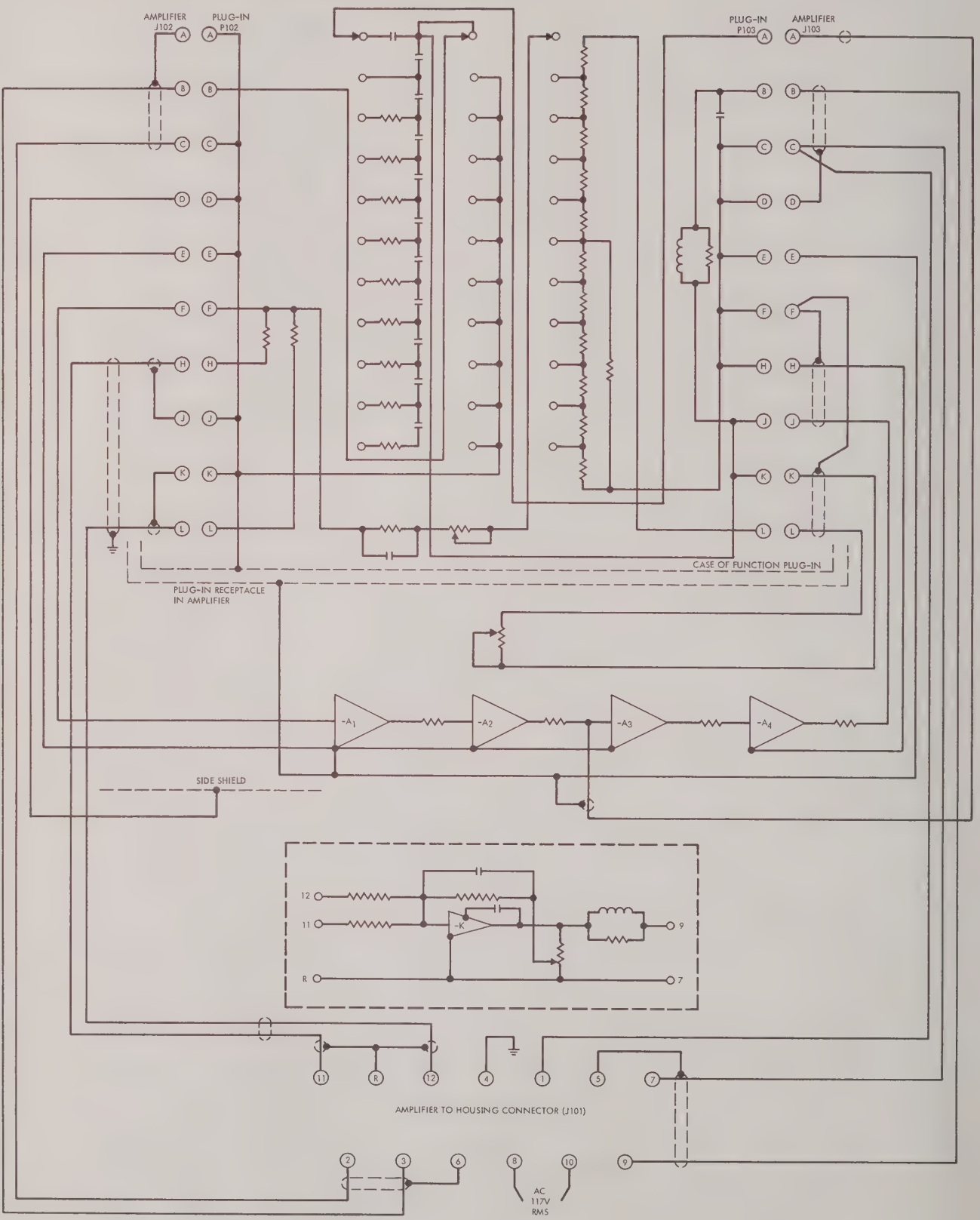


Figure O2-4. Typical Summing Network Constructed in 112A-O Plug-In

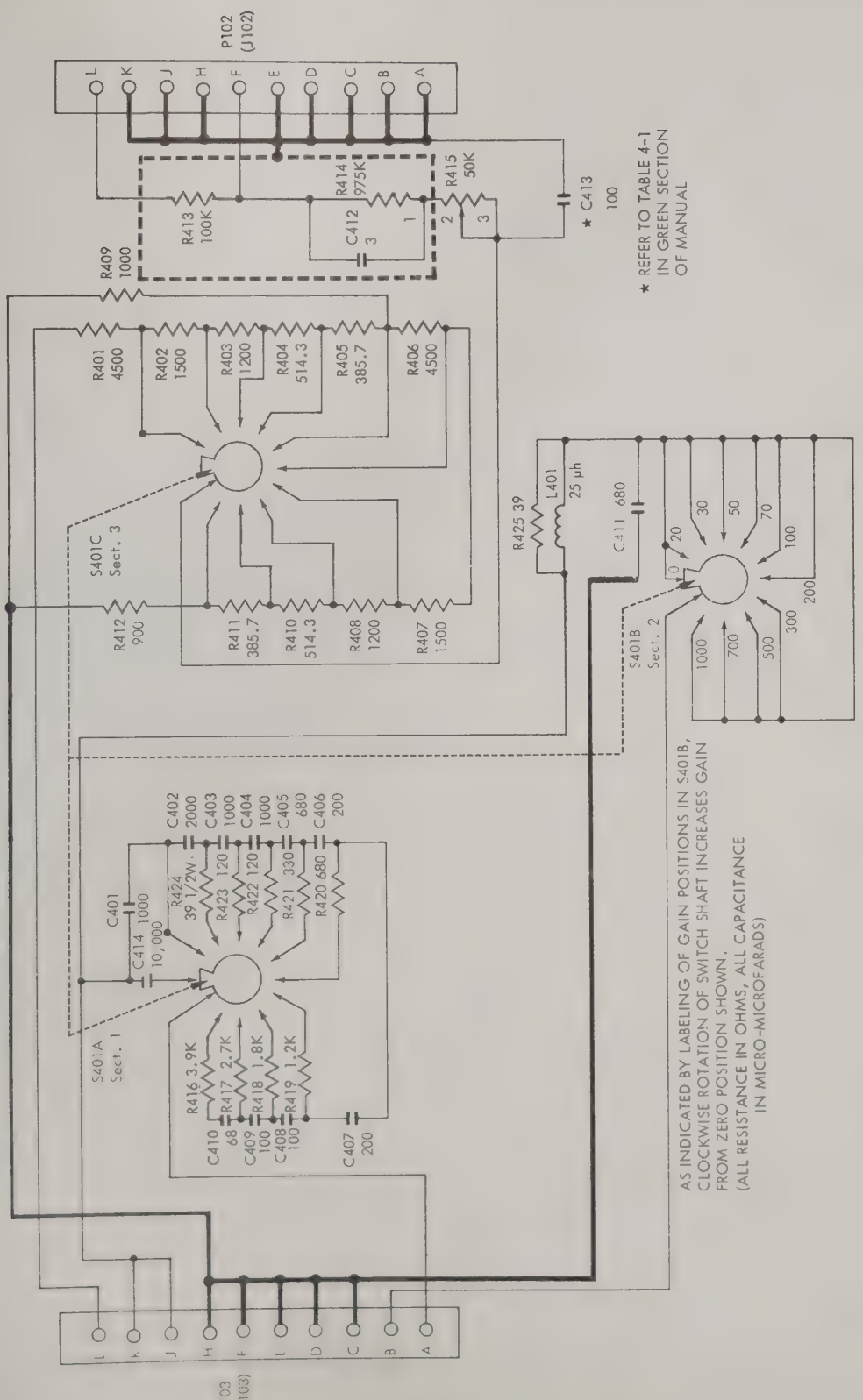


Figure O2-5. Schematic Diagram: Model 112A-AO Function Plug-In (Operational Variable Gain)

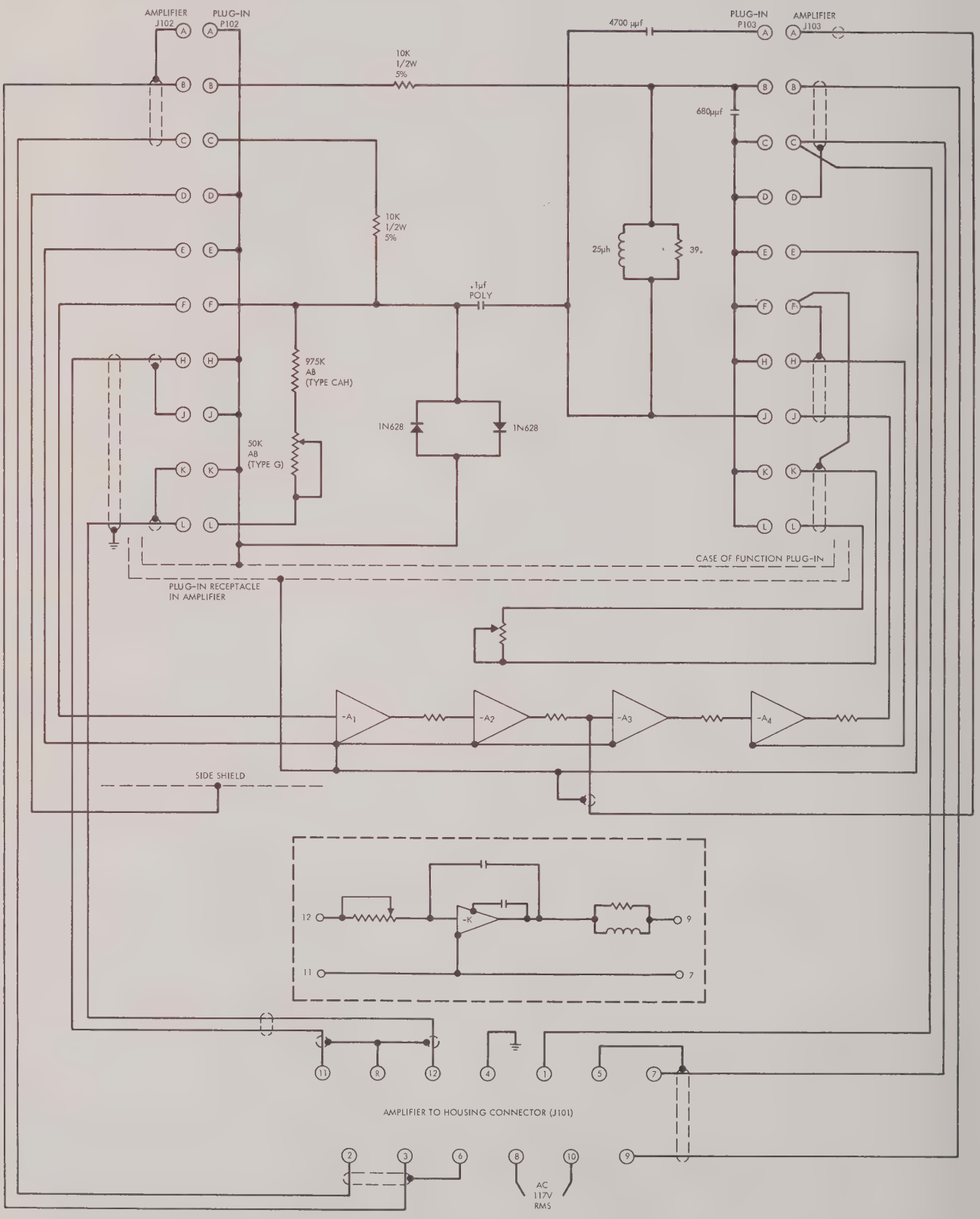


Figure O2-6. Typical 0.1 Second Integrator Constructed in 112A-O Plug-In

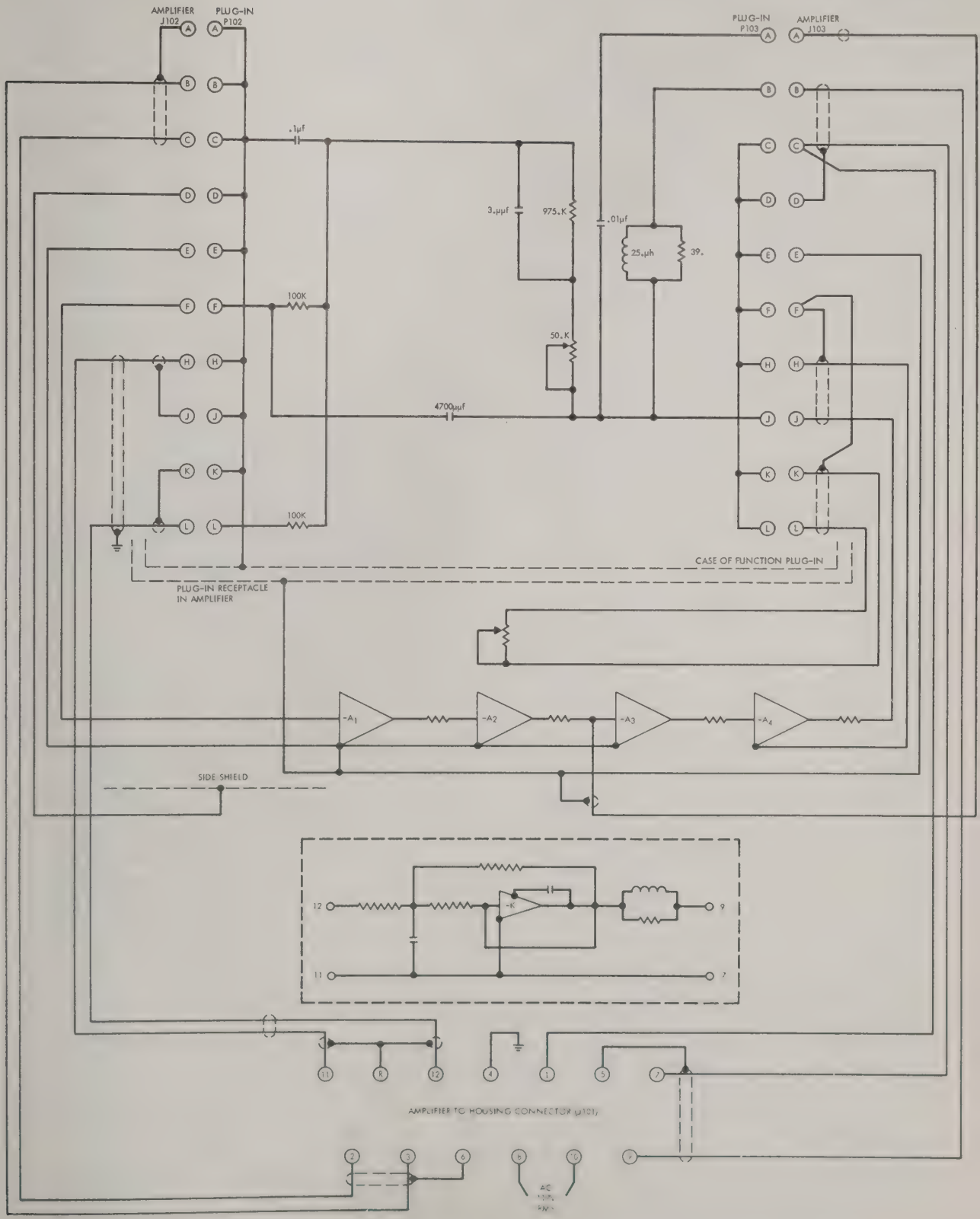
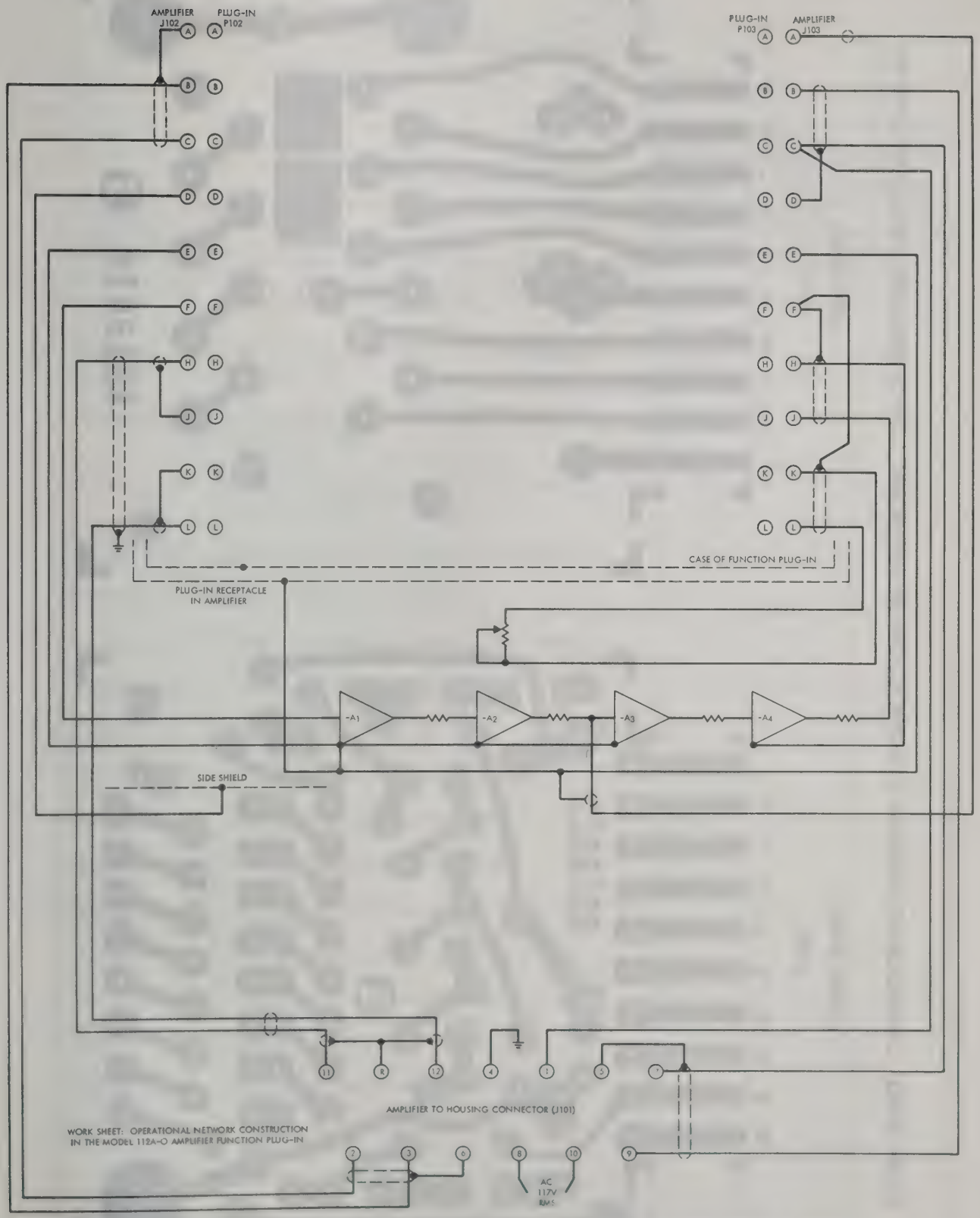
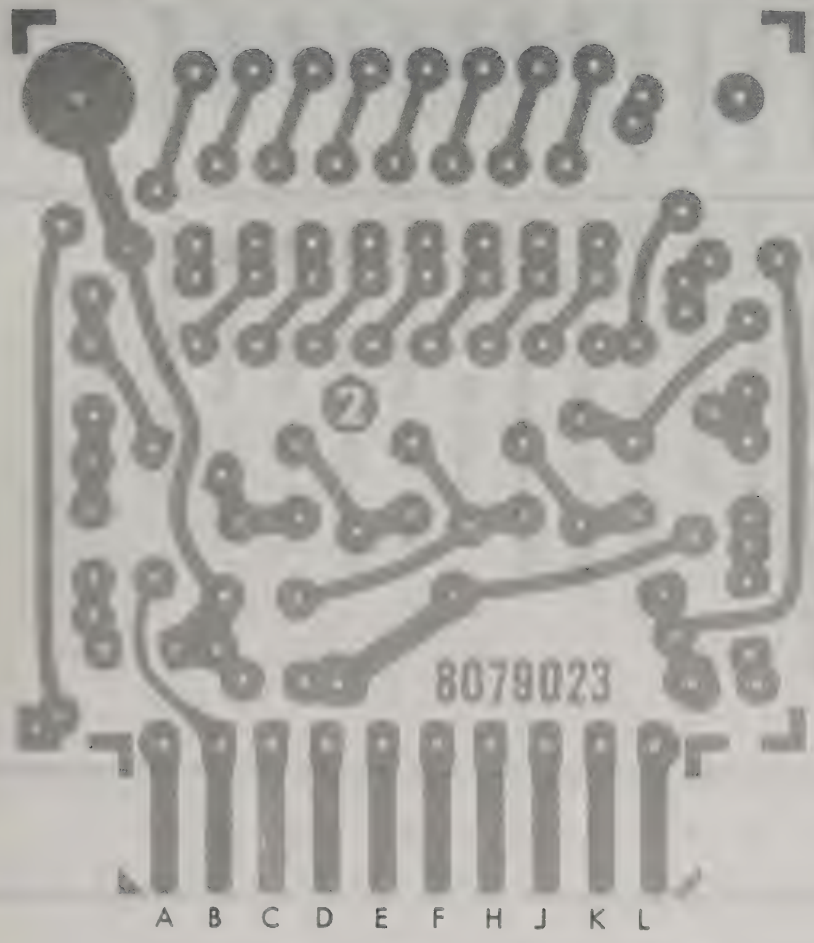


Figure O2-7. Typical Second-Order Filter Constructed in 112A-O Plug-In

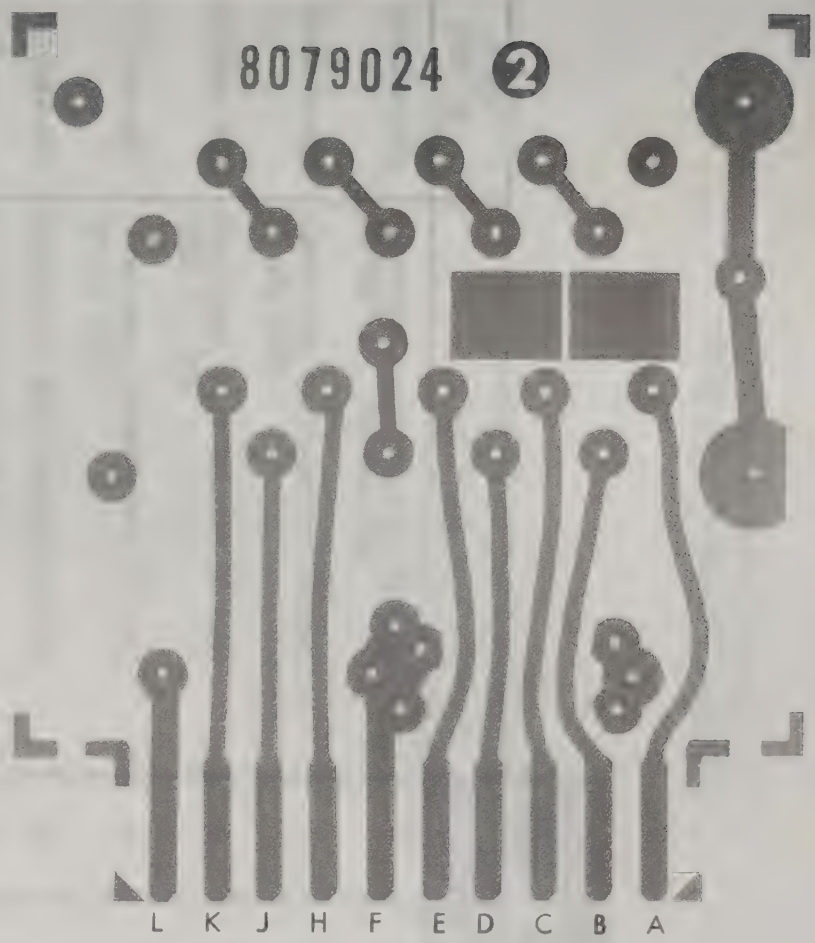


WORK SHEET: OPERATIONAL NETWORK CONSTRUCTION IN THE MODEL 112A-O AMPLIFIER FUNCTION PLUG-IN

SHEET: OPERATIONAL NETWORK CONSTRUCTION IN THE
MODEL 1124-O AMPLIFIER FUNCTION PLUG-IN



P103
Output board



P102
Input board

WORK SHEET: OPERATIONAL NETWORK CONSTRUCTION IN THE MODEL 112A-O AMPLIFIER FUNCTION PLUG-IN

Work sheet: Organizational relationships of the model 11 to-do-what-when-how-in

Recommended Spare Part Kits for COHU
Model 112A Wideband DC Amplifier

COHU PART NO.	DESCRIPTION	KIT NUMBER 80771 PK001 STOCK LEVEL 1 UNIT	KIT NUMBER 80771 PK005 STOCK LEVEL 5 UNITS	KIT NUMBER 80771 PK025 STOCK LEVEL 25 UNITS
0510061-012	CAPACITOR, ELECTROLYTIC PC CAN, 30/40/8 UF, 450/450/150V	0	1	3
0510121-005	CAPACITOR, ELECTROLYTIC PC CAN, 80 UF, 450V.	0	1	3
0510061-022	CAPACITOR, ELECTROLYTIC PC CAN, 1000 UF, 15V	0	1	3
0510121-001	CAPACITOR, ELECTROLYTIC PC CAN, 50 UF, 450V	0	1	3
1310064-001	CONNECTOR, AMPLIFIER-TO-HOUSING	0	0	1
1704151	LAMP, NEON, TYPE NE2	0	1	2
1710036-001	LAMP, INDICATOR, NEON, MINIATURE	0	1	2
1710040-019	FUSE, SLO-BLO, 1 AMP, 125V	2	4	8
1810003-001	CELL, MERCURY 1.35V	3	6	9
3510053-006	DIODE, SILICON, TYPE 1N3563	2	4	8
3510053-003	DIODE, SILICON, TYPE CER69	2	4	8
3506774-007	DIODE, SELENIUM, TYPE 3U1	2	4	8
6310017	CONVERTER, 60-CYCLE	1	2	5
7002748	TUBE, VACUUM, TYPE 6AU6	2	3	8
7002768	TUBE, VACUUM, TYPE 6BX7GT	1	2	4
7002773	TUBE, VACUUM, TYPE 6CB6	1	2	4
7302812	TUBE, VACUUM, TYPE 5751	2	4	9
8077031-001	TRANSFORMER, POWER	0	0	1

Recommended Spare Part Kits for COHU Model 112A-A Amp. Function Plug-In

COHU PART NO.	DESCRIPTION	KIT NUMBER 80791 PK001 STOCK LEVEL 1 UNIT	KIT NUMBER 80791 PK005 STOCK LEVEL 5 UNITS	KIT NUMBER 80791 PK025 STOCK LEVEL 25 UNITS
0406759-029	CAPACITOR, COMPOSITION, 3UUF, 500V, 5%	0	1	2
4806790	RESISTOR, 385.7 OHMS, .25R	0	1	2
4806791	RESISTOR, 514.3 OHMS, .25%	0	1	2
4806792	RESISTOR, 900 OHMS, .25%	0	1	2
4806793	RESISTOR, 1K OHMS, .25%	0	1	2
4806794	RESISTOR, 1.2K OHMS, .25%	0	1	2
4806795	RESISTOR, 1.5K OHMS, .25%	0	1	2
4806796	RESISTOR, 4.5K OHMS, .25%	0	1	2
5210068-003	RESISTOR, HIGH STABILITY, 100K OHMS, 1/4W, .5%	0	0	1
5210068-005	RESISTOR, HIGH STABILITY, 975K OHMS, 1/4W, .5%	0	0	1

WARRANTY

COHU ELECTRONICS, INC., warrants equipment manufactured to be free from defects of material and workmanship. Any part or parts will be repaired or replaced when proven by COHU examination to have been defective within one year (90 days for batteries, fuses, transistors and tubes) from date of shipment to the original purchaser. All warranty repairs will be performed at the factory or as otherwise authorized by COHU in writing. Transportation charges shall be prepaid by purchaser.

This warranty does not extend to COHU equipment subjected to misuse, accident, neglect or improper application; nor repaired or altered by other than COHU or those authorized by COHU in writing.

This warranty is in lieu of all other warranties express or implied. COHU shall not be liable for collateral or consequential damages.

For customer convenience, service departments are maintained throughout the United States by COHU Field Engineering Representatives.

COHU
ELECTRONICS, INC
SAN DIEGO CALIFORNIA

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